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SPECIFICATIONS FOR THE INSTALLATION of steam engines were considered at the meeting of the Engine Builders' Association of the United States, at Indianapolis, on May 27 and 28. The Association, through its Secretary, Mr. S. F. Bagg, of Watertown, N. Y., offers the following suggestions for the consideration of architects and engineers who may draw specifications for the installation of steam engines:

(1) That contracts which provide a penalty for failure to deliver in time or for failure to meet guaranties ought also to provide equal premiums for earlier delivery or better results than specified.

(2) That bonds should not be required on installation contracts unless corresponding bonds for similar amounts are given to secure payment. An exception always being made in the case of government, state or municipal contracts.

(3) That settlements or any part of them ought not to extend beyond three months from completion of contract, and that delay on the part of the owner ought not to delay payment beyond a reasonable time.

(4) That a guaranty against defective material or workmanship should not be made to cover a period of more than one year from date of shipment.

(5) That purchasers of engines ought not to be furnished with complete working drawings, but simply with general drawings showing the assembled engine in outline, with such principal dimensions as will answer for building foundations, the erection of engines or their care.

AUTOMATIC CONTROL of the fan-motor speed in mechanical-draft installation is provided for in a plant recently built by the Buffalo Forge Co., of Buffalo, N. Y. A special motor controller is actuated by the change of the boiler pressure, and in this way a very close regulation of the latter can be secured with little attention on the part of the fireman.

A COAL CONVEYOR for facilitating the unloading of gondola cars has been installed by the Chicago Edison Co. at their Harrison street station. The conveyor was built by the Robins Conveying Belt Co., under the supervision of Messrs. Sargent & Lundy, of Chicago. It rests on rails alongside the car track and is used to bring the coal from as many as six cars to a common point without it being necessary to shift the cars. It also makes it possible for the men to be shovelling from three cars at once. The coal is delivered to a hopper from which it is fed to a cross conveyor and carried to the bins.

THE PENNSYLVANIA RAILROAD CO. has secured control of the Pennsylvania and Cambria Steel companies, according to a published statement by the chairman of the Board of Directors of the United States Steel Corporation, in which assurance is given that the two companies will be operated in harmony with the United States Steel Corporation. It will be apparent that by this move the Pennsylvania Railroad Co. places itself in a position to control the cost of the iron and steel required for the supply of the entire Pennsylvania system and the lines associated therewith under the "Community of Interest" plan.

THE SHELBY STEEL TUBE CO., the most important independent competitor of the National Tube Co., has been acquired by the United States Steel Corporation, according to an official statement by J. P. Morgan & Co. on June 24.

OIL PIPE LINES AND STEEL OIL-TANKS are interesting the oil men of the Beaumont, Tex., region. The Houston "Post" says that about 2,000 men are now employed in the Beaumont oil field, and that large quantities of pipe are arriving daily. That journal figures the cost of pipe lines at about $10,000 per mile. It also states that the two cotton-compress plants at Brenham, Tex., are arranging to use oil as fuel instead of coal.

ONE OF THE LONGEST NATURAL GAS MAINS ever laid is a pipe of the Philadelphia Co. extending from the gas fields of Wetzel County, W. Va., to Pittsburg. The pipe is 90 miles in length and 10 ins. diameter. The initial pressure at the wells is about 350 lbs. and the discharge pressure is from 10 lbs. to 50 lbs. With this drop the pipe delivers about 10,000,000 cu. ft. of gas per 24 hours.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the West Virginia Central & Pittsburg Ry., near Hendricks, W. Va., on June 20. The breaking of a flange on the pony truck of the locomotive of a freight train caused the locomotive to leave the track at a sharp curve on a bridge. The locomotive, with several cars, was precipitated to the bottom of the Dry Fork River, resulting in the deaths of three men.

A FLOOD SWEPT THE ELKHORN VALLEY in West Virginia on June 22, entirely or partially destroying several mining towns and destroying the bridges and tracks along 30 miles of the Norfolk & Western Ry. In the town of Keystone several hundred houses are reported to have been carried away and the total loss of life by the flood is variously estimated at from 50 to 200. This is the Pocohontas coal district and many of the mines are flooded. The property loss of the Norfolk & Western R. R. is said to be about $500,000.

A WATER-WORKS RESERVOIR at New Berlin, N. Y., narrowly escaped destruction on June 22 as the result of an extraordinary rainfall. The area supplying the reservoir is about 1,500 acres. The reservoir is confined by an earth dam, with a waste weir at one end 30 ft. in width, delivering into a masonry chamber. The water overtopped the walls of this chamber and cut away the earth behind them. Logs coming down with the current then demolished one wall, and the current was turned against the toe of the earth dam. Fortunately the surplus water was discharged before the cutting had proceeded far enough to endanger the structure.

THE AUTOMATIC COALING BARGE, "CLARK NO. 2," described in our last issue, was overturned by a gust of wind and sank in Staten Island Sound on June 24, while proceeding to New York city under her own steam. All of the crew succeeded in escaping except the steward, who was carried down with the barge. The barge has since been righted and raised and was found to be uninjured.

AN ELECTROLYSIS DAMAGE SUIT at Pittsburg, Pa., has been brought against the United Traction Co. by Mr. Wm. McMahon, on account of the failure of a lead pipe supplying the Home Hotel. The failure, it is alleged, was due to electrolysis. The damages sought are to cover the expense of repairs to the service pipe and extra labor employed to supply the hotel with water while the service was out of use.

ELECTRICAL SUBWAYS for the business section of Troy, N. Y., are called for by an ordinance adopted by the city council. The wires must be underground by July 1, 1902.

AN ELECTRIC SURFACE-CONTACT SYSTEM in which the switching is done by mechanical means has been invented in England, and an experimental line has been laid down at Wolverhampton. A revolving tappet wheel is operated by a striker-bar attached to the car. The wheel is placed in a slot beside one of the rails and is given a one-sixth turn by the striker-bar when the car passes, which switches on the contact stud which the car is approaching and switches off the one which it is leaving.

THE ILLINOIS AND MICHIGAN CANAL will no longer be supplied with water pumped from the Chicago Drainage Canal, the Illinois Supreme Court having rendered a decision which releases the Sanitary District from the obligation of maintaining a navigable depth of water in the I. & M. Canal. The obligation was entered into by the Sanitary District as the Canal Commissioners refused to give a right of way through Joliet unless this was done, but the District has maintained that it was not just and has sought to be relieved of the burden. The lower court decided that the Sanitary District must maintain a navigable depth in the old barge canal from April 1 to Nov. 1 of each year, but the Supreme Court has reversed this decision. The pumping plant will now be shut down, and a saving of about $2,500 per month effected.

RIVER AND HARBOR WORKS were the subject of discussion at the recent Southern Industrial Convention held in Philadelphia, and the following resolution was adopted:

That the Southern Industrial Convention respectfully recommends to the Congress of the United States the creation of a board or commission to be composed of eminent civil, military and naval engineers, to which shall be committed the care and improvement of our rivers, harbors and connecting waterways, in which tenure of office shall be permanent unless removal is made for cause, and in the service of which promotion shall be made in accordance with ability.

A DEEP WATERWAY ACROSS HUDSON CO., near the line of the abandoned Morris Canal, between Jersey City and Bayonne, is being discussed. A similar canal was proposed in the 70s, but was never built. The present agitation is probably part of the enterprise for reclaiming the Hackensack Meadows and creating factory sites, railway terminals, docks, etc., on this now waste land. Such a deep waterway would directly connect New York Bay with the improved Newark Bay. It is said that Jersey City or Hudson Co. will lay claim to this canal site at the next meeting of the New Jersey Legislature in return for certain rights relinquished.

THE DRAINAGE OF THE HACKENSACK MEADOWS is proposed by the Hackensack Meadows Co., which was lately incorporated with a capital of $3,000,000. The area of marsh land secured amounts to 3,393 acres; and the plan, as far as known, proposes to surround this area by a system of dykes or levees, and to keep the interior area drained by pumping. The levees will be wide enough to hold warehouses located alongside the deep surrounding canal; and the interior will be converted into sites for factories, etc. A belt railway, connecting with the lines now crossing the meadows and with the interior is included in the plan. Docks will be built on the Hackensack and Passaic rivers, and an effort will be made to induce the government to increase the depth of these rivers by dredging.

THE DRAINAGE OF THE ZUYDER ZEE is again proposed in the Holland States General. This sheet of water does more harm than good to Holland; and a dike at the northern end would add 500,000 acres of fertile land to the State. It is estimated that this sea could be drained in about 18 years, at a cost of about $38,000,000; the land reclaimed would be worth $160,000,000. Included in the above cost is the sum of nearly $2,000,000 to be paid as an indemnity to Zuyder Zee fishermen.

THE CHICAGO RIVER IMPROVEMENT is to be started by dredging to a depth of 26 ft. in the south channel, from Lake to Robey streets, according to a decision of the Board of Trustees of the Sanitary District. Two of the trustees objected to the work being done at this time as the tunnels still limit the draft of vessels, and it will be impossible to dredge to the full depth near the center piers of swing bridges. They consider that the obstructions should first be removed and the entire channel then dredged. It has at various times been rumored that the Sanitary District would undertake the work of lowering the obstructive tunnels, the cost of which is estimated at $2,500,000 by Mr. Randolph, Chief Engineer of the District, and at $850,000 by Mr. Ericson, the City Engineer. It now appears that this will not be done, as the necessary capacity of flow can be obtained by removing the center pier bridges and widening and deepening the channel. The work of lowering the tunnels is therefore left to the city.

POWER FROM NIAGARA FALLS will soon be delivered in Toronto, Can. It is reported that the Toronto Street Ry. will take 10,000 HP. and the Toronto Electric Light Co. about 5,000 HP. The charge for this power delivered at the borders of the city will be $25 per HP. per year for 24 hours per day.

BIDS FOR THE SEWERAGE AND PAVING OF HAVANA, Cuba, will be readvertised, as stated in our advertising columns. The new bids will be opened on Sept. 25. The specifications have been modified in a few particulars, chiefly in regard to quantities. The detailed bids received for the sewerage work, as a result of the first call, were given in our issue of June 13; the corresponding bids for paving are given in the supplement to this issue.

AN EXPOSITION OF HYGIENE, MARITIME SECURITY and Fishery will be held at Ostende, Belgium, during August and September of this year. The especial object of the exposition is the use and working of life-saving apparatus, in great catastrophes on sea or land. Demands for space must be made not later than Aug. 1, to the committee of organization, 18 Rue des Soeurs Blanches, Ostende, Belgium. The price of isolated sites is 40 francs per sq. meter and 25 francs per meter for sites not isolated.

THE WATER SUPPLY OF GIBRALTAR.

By Wm. P. Mason.*

Gibraltar is, beyond all things else, a fortress. The visitor is continually reminded of this fact, not only by the visible signs of military occupation everywhere present, but also by the rules and regulations with which the place positively bristles. The assumption upon which the garrison appears to act is that a state of war continually obtains, and that a hostile attack should be momentarily expected.

The bold-faced "Rock of Gibraltar," with the pictures of which we are all so familiar, rises sheer from the "Devil's Tower Road," on the "North Front," Fig. 2, and faces the land side, not the sea, as most people fancy. It looks towards Spain, and makes the approach of an enemy from that direction all the more difficult. The east side is also very precipitous; while the west slope (Fig. 3), although decidedly steep, permits of enough fairly level ground being found at its base to furnish a foothold for the "city" with its circumvallating walls.

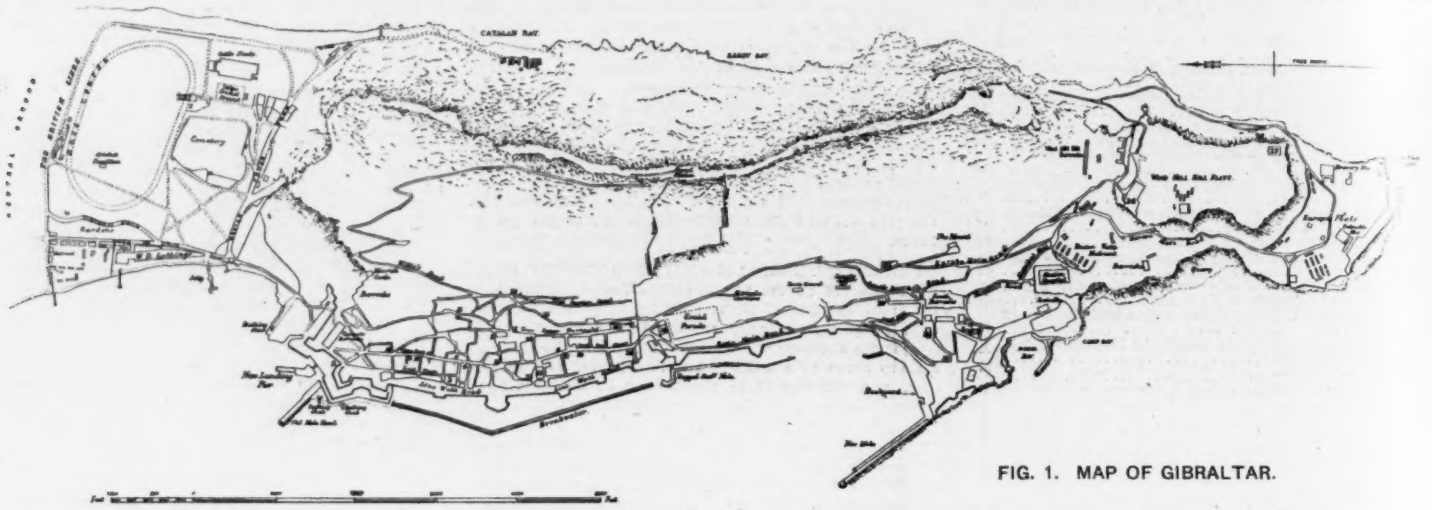

FIG. 1. MAP OF GIBRALTAR.

So carefully are the military secrets of the rock guarded that even the officers of the post are individually not fully informed as to the nature of the defences outside of the section where their duties lie. To such an extent is this carried that the engineer officer, whose duty it was to design the works for the new water supply, told the writer that he could not go up the west face of the rock until his pass had been signed in England.

It may be easily imagined that the foresight which goes so far as to cause the garrison to be fed on "siege rations" one day in each week would not permit the possibility of such garrison being deprived of its water supply through the action of an enemy.

From the accompanying map, Fig. 1, it will be noticed that the area of "Gibraltar" is small, but

FIG. 2. NORTH FACE OF ROCK OF GIBRALTAR.

that portion of it which is within the old walls, and which constitutes the "city" is densely populated. Roughly speaking, the civil population at present may be placed at 20,000, while the garrison numbers 6,000. These figures would be, of course, liable to some modification in time of actual war.

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These ramparts were strong indeed for the days in which they were built, but now they are unarmed except for an occasional old smooth-bore of antiquated type. The real defenses of the place are invisible to the stranger, who cannot locate a single piece of modern artillery, unless he should chance to be present upon some day of gun-drill, when he quickly becomes aware that the cannon are very many and very large.

Gibraltar is not limited to a single source of water supply. For ordinary uses, such as flushing, street sprinkling, and the like, a brackish water is used, which is derived from wells sunk in the flats north of the rock, and near the neutral grounds. The supply so secured is about 25% sea water in winter, and about three times that amount in summer, owing to the variation in seasonal rainfall. It is pumped to a tank located in the "Moorish Castle," Fig. 4, a portion of the ancient defenses, and flows thence to the town by gravity. This water is metered and charged for at the rate of ¼-peseta for 100 Imperial gallons, or about 40 cts. per 1,000 U. S. gallons.

The triple expansion Worthington engines which raise the brackish water from the wells on the north front, have sufficient power to pump 240,000,000 U. S. gallons of water per an[illegible] to a height of 270 ft. For fuel, the total cost [illegible]umping to a height of 270 ft., and to an aver[illegible]hor-zontal distance of 6,600 ft., is about 3.7 [illegible] per 1,000 U. S. gallons.

Situated not far from the "Alameda G[illegible]ens," on the west slope of the rock, is a distilli[illegible]plant for furnishing a potable supply from se[illegible]ater. The apparatus is well protected and read[illegible]r an emergency, but is not ordinarily in use.

The principal water supply for Gibralta[illegible] obtained from the rain, and a careful in[illegible]tion of the west face of the rock (Fig. 3), will show a whitish patch near the top which acts as the catchment area. This area contains about sixteen acres, and has been carefully cemented at a cost of 1½ pesetas (about 30 cts.) per sq. yd. The water falling thereupon, averaging 33½ ins. annually, passes through a rough strainer of "polarite" and sand, and is thence delivered into the underground storage reservoirs, which are at present four in number.

All four storage reservoirs (Fig. 5) are of the same size, and are of tunnel form, being 201 ft. long, 22 ft. wide at the top, and 18 ft. wide at the bottom, with a height of 51 ft. The sides are stepped off by 4-in. ledges every 7 ft., measured vertically. The sides, bottoms and ends are concreted and then plastered with four coats of a mixture of equal parts of cement and fine limestone. The filtered rainwater is admitted to each tunnel through an 18-in. cast-iron pipe, carried to the bottom of the chamber.

Security against the shell fire of an enemy is not the only advantage of this form of water storage, for it must be remembered that the absolute darkness which prevails under such conditions inhibits the growth of aquatic vegetation, and the temperature of the water is maintained constantly at a low degree, in this instance 50° F.

The exact location of these reservoirs it is not permitted the outsider to know, although their general form and dimensions are given above. The internal measurements are correct, as stated, but the true angle of slope of the exterior rock face is intentionally withheld. It will be noticed that the exterior ends of the tunnels are not excavated. This is for the protection of the water supply against the artillery fire of a besieging force.

Designs have been completed and work is now in hand for a much larger storage system, to consist of a tunnel driven through the entire rock from side to side, excepting, of course, the unexcavated ends. Exact information covering this development it is, naturally, impossible to secure, but the rough sketch, Fig. 6, will sufficiently illustrate its general character.

The tunnel will be about 400 ft. above sea level, will be 2,000 ft. long, with a sectional area of 1,311 sq. ft., and will dip slightly toward the west. It is estimated to cost £150,000, or about $730,000, and the proposition is to pay for it by an issue of sixty-year 3% bonds. Necessarily the catchment area will have to be materially increased to provide water enough to fill this new reservoir.

The rate of consumption of potable water in Gibraltar is very low. The estimated consump-

for an entire year is only 10,000,000 gallons for the whole civil population.

Many of the citizens of Gibraltar store in their own private cisterns such rainwater as they are able to catch upon their roofs; there are 690 such cisterns. In default of this they purchase their supply from the government at the rate of one penny

FIG. 3. WEST FACE OF ROCK OF GIBRALTAR

for ten Imperial gallons, or two cents per twelve U. S. gallons. The writer was informed that this rate is doubled when recourse is had to the apparatus for distilling sea-water. Although the water as stored in the reservoirs is of excellent quality, the system of delivering it to the houses in more or less impure kegs, which are filled at the public hydrants, is not an arrangement of special merit from a sanitary point of view. It is an unfortunate fact that very many houses in the city are not supplied with direct water connection.

FIRE RETARDANT TREATMENTS OF WOOD.*

Your committee considers it advisable to divide the report into two main topics: (1) Fireproofed wood, that is wood chemically treated internally as well as externally so as to render the wood practically non-inflammable throughout; (2) Fire retardant coatings for wood such as paints and compounds of a similar nature.

I. FIREPROOFED WOOD.

It is our aim simply to present such information as we have been able to gather regarding the various

Fig. 4. View of Moorish Castle, Containing Tank for the Brackish Water Supply of Gibraltar.

kinds of fireproofed wood now on the market, as to its general features, good or bad, processes used, tests made, etc. We have taken up the subject only in its connection with the processes of recognized standing.

*Abstract of a committee report presented at the annual meeting of the National Fire Protection Association, at Chicago, June 11-13.

It would appear that there are practically but two companies which are prepared to supply the so-called fireproofed wood in quantities sufficient to meet any ordinary demand: the Electric Fireproofing Co., 119 West 23d St., New York city, and the American Wood Fireproofing Co., Bowling Green Building, New York city (works at Newark, N. J.). There also appears to be at least one other organization advertising as manufacturers of fireproofed wood: the New York Fireproof Wood Co., 38 Park Row, New York city, but this concern is not yet prepared to supply the market.

Wood treated by the Electric Fireproofing Co. has been in use and on the market for some six years. About 1895 it furnished some wood to the U. S. Government for use in war vessels, and has since that time done considerable Government work.

Practically all of the U. S. warships of recent date are furnished with wood treated by this company's process. This company has also supplied wood for several of the large fireproof buildings in New York city. Also a large amount of smaller work including some for telegraph, telephone and electric companies.

The American Wood Fireproofing Co. has had its product on the market but a comparatively short time. It has furnished fireproofed wood for the Western Electric Instrument Co.'s building at Newark, also some for the house of the New York Yacht Club. Also the wood has been used by the Ordnance Bureau at the Brooklyn Navy Yard. We understand that the contract for the U. S. S. "Baltimore" has been awarded to this company.

PROCESSES.—The electric fireproofing process is known as the Bachert process. The wood is placed in large steel cylinders and steam is admitted under light pressure. After a time, the steam is withdrawn and a vacuum created which draws the sap and dissolved resins and gums from the wood. A solution of phosphate of ammonia and sulphate of ammonia is then introduced and varying pressures applied according to the thickness and nature of the wood to be treated, but not exceeding approximately 200 lbs. per sq. in. After treatment, the wood is kiln dried for a considerable length of time.

In the American process, wood is steamed under 10 lbs. pressure, then the sap is withdrawn by means of a vacuum as in the former process. After the sap is withdrawn, any acid remaining in the fiber is neuturalized. A chemical solution is then introduced under 200 lbs. pressure. It appears that various combinations of chemicals have been used and patented by this company, including the soluble sulphates such as ammonia, sodium and zinc.

The New York fireproofing process is known as the "Ferrell" process. We do not know what chemicals are used in this process. There is no steaming or vacuum used. A heavy pressure (said to be even as high as 1,200 to 1,500 lbs. per sq. in.) is used to force chemical solutions into the wood. Steam heat is used to aid in this process.

TESTS.—A number of tests have been made on wood treated by the companies noted, with results which, we think, may be considered generally satisfactory.

Tests have been made by the U. S. Government, also by the New York Building Department and by the British Fire Prevention Committee, etc. Your committee can hardly consider these tests conclusive, as the data obtainable is meager, as the Government and the Building Department of New York publish no detailed reports of the tests. The results of tests by the British Fire Prevention Committee as applied to wood treated by the Bachert process appear to be satisfactory.

Taking the tests as a whole, they appear to show that the wood has been so treated by at least one of these companies as to render it non-inflammable to such a satisfactory extent that there appears to be no reason to question the entire practicability of treating wood by processes as outlined so as to render it non-inflammable.

Tests have been made at the Stevens Institute of Technology and by the Ordnance Department of the U. S. with reference to weight, strength, etc. One test as reported shows that the wood increases in weight from 34 lbs. per cu. ft. to 68½ lbs. after treatment, which again decreases to 37⅝ lbs. after kiln drying, that is, the final gain in weight over untreated wood is about 10%.

Tests for strength show approximately as follows: White pine shows a gain in transverse or breaking strength of 7%. Yellow pine shows a loss of transverse strength of 12.6%. Compression tests show a loss of from 6.1 to 9.2%. Tension tests show a gain of 19 to 24%.

Wood fireproofed by the Electric Fireproofing Co. has been used by the U. S. Government some five years. During the past year, extensive tests have been undertaken at the Boston Navy Yard. They were to determine the comparative value of wood fireproofed by the American Wood Fireproofing Co., and the Electric Fireproofing Co. We understand that none of the first-named company's wood has been used in the navy up to the present time, but as a result of these tests it appears that it has now obtained the approval of the Government and can compete with the Electric Fireproofing Co. in this line of work. No published reports of these tests are obtainable.

The New York Building Department has made tests on wood as fireproofed by the Electric Fireproofing Co., the American Wood Fireproofing Co., and the New York Fireproof Wood Co. In their reports, it is stated that the wood as made by the Electric Fireproofing Co., is acceptable, and that other makes of wood are not acceptable, and from such information as we have secured the reports of the tests on wood as treated by the last two companies appear to show that they did not successfully withstand the tests.

Under the building laws of New York, fireproofed wood is required in all buildings over 12 stories in height, so that apparently at the present time the only wood which

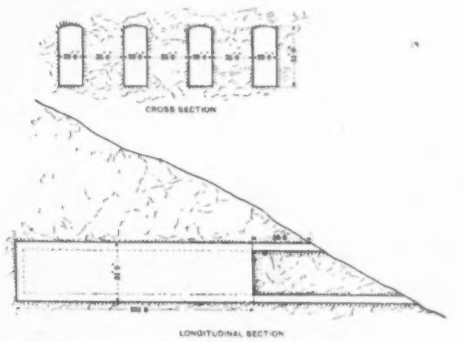


Fig. 5. Sections of Storage Tunnel-Reservoirs at Gibraltar.

can be used in such buildings is that treated by the Electric Fireproofing Co. In this connection, it may be well to note that the New York Fire Insurance Exchange in its schedule of rates covering fireproofed buildings gives a reduction of 5% from the building rate when all woodwork is fireproofed.

COST.—The cost of ordinary lumber not exceeding 1-in. in thickness as fireproofed by the Electric Fireproofing Co. is $50 per M. B. M., with an additional $15 for kiln drying, making a total of $65 per M. The price of the American process is about $5 less than the above.

It is claimed that timbers as large as 12 × 12 ins. can be completely treated. We have seen timbers 6 ins. thick which apparently had been rendered thoroughly non-combustible, as slivers taken out of the interior would not burn. The cost of such large fireproofed pieces is much greater than noted above.

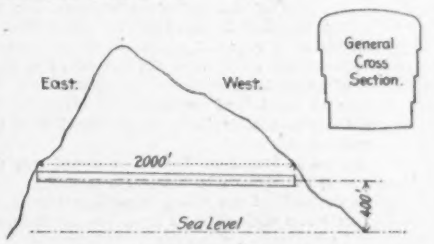


Fig. 6. Sketch-Sections of New Storage Tunnel-Reservoir at Gibraltar.

PERMANENCE.—Tests have recently been made by the Government on wood taken from the torpedo boat "Winslow." This wood was fireproofed by the electric fireproofing processes and had been on the boat five years. The report shows that pieces of the wood were subjected to various kinds of heat and flame tests, and it would appear that the wood had not in any appreciable degree regained its inflammable qualities.

CORROSION.—It is absolutely essential that wood be thoroughly dried before using. There has been some trouble from corrosion of metal in contact where fireproofed wood has been used. It would appear that wood can be treated and thoroughly dried so that if used in the ordinary dry atmosphere generally found inside of buildings in our climate, it should not give trouble from corrision. A good coating of paint or varnish is undoubtedly a desirable feature. We understand that the U. S. Government had made tests of fireproofed wood first coated with Kaseine or fire retardant paint and then finished with varnish paint which treatment appears to mitigate if not overcome any trouble from corrosion.

Where trouble from corrosion has been reported, it seems to be at least probable that faulty preparation of the wood was a prominent factor, also that it may possibly in some measure be due to the use of deliquescent salts in treatment.

FINISH.—Wood treated by the above fireproofing process appears to take a finish better than does untreated wood owing to the fact that it is already filled by the fireproofing salts, and therefore, needs no other preparation to fit it for the application of paint, varnish or polish. There is some question, however, whether the finish is not more liable to blister or check than on untreated wood.

WORKING FIREPROOFED WOOD.—From all that we can learn, it would appear that while wood which has been fireproofed is harder to work than untreated wood, still this difference would not seem to be any greater than that known to exist between certain soft and hard woods in common use.

CONCLUSION.—It appears that wood can be so treated as to render it practically and permanently non-inflammable. The expense of such treatment is large and the cost of the treated wood renders it almost prohibitive for general use.

The methods of treatment which present the most favorable results appear to be the costlier, i. e., the better chemicals to use are more expensive than some others that are either being used or are liable to be used in such processes. This in itself is an undesirable feature on account of the tendency there will be to use cheap, objectionable and less effective chemicals. It is also evident that even in the most approved and successful of fireproofing processes, its value depends upon the thoroughness and care exercised in the treatment.

Assuming that satisfactory processes have been or can be devised, we think it will be very difficult to guard or legislate against such undesirable features as careless or improper treatment, incomplete drying or use of objectionable chemicals and we think that this side of the question should receive careful consideration by the Association before deciding to proceed further with this subject.

II. FIRE RETARDANT COATINGS FOR WOOD.

So far as the general aspect of this matter is concerned, we would refer to the report made to this Association two years ago by the Committee on Fire Retardant Paints. There are at present on the market a large number of paints and similar compounds properly classed as fire retardants, in comparison with such coatings as ordinary oil paints, varnishes and the like; but as there are so many compounds on the market and in the absence of any specific and convincing tests, your committee does not feel that it is in a position to judge between the conflicting claims of the various manufacturers.

We are, however, of the opinion that several of these compounds have considerable value as fire retardants and are deserving of careful consideration by the Association, and we would recommend that compounds of this nature be referred to the laboratory for investigation and test.

In taking up the subject of the proper method of testing fire retardant coatings, we wish first to call attention to the fact that the basis for tests of surface fire retardants is entirely different from that under which fire doors, fire stop partitions or similar materials should be tested. In the case of fire retardant coatings, the resistance is not expected to continue for more than a brief period, but it is expected to have sufficient quality of non-inflammability to prevent the spread of a flash fire or one of short duration over any considerable exposed surface of wood, and by excluding air from the adjacent surfaces to greatly diminish the rapidity of the spread of combustion.

In making tests on coated wood, we recommend that the following general conditions be observed:

1. Tests to be made of the action of wood protected by such a coating when subjected to a flame test of moderate intensity and moderate area approximating as nearly as possible to the intensity of the ordinary fire during its early stages.

2. Tests to be made by burning moderate quantities of chaff or similar combustible material on horizontal surfaces to determine, if possible, whether the coatings would resist slow heat generated by the burning of a pile of dust or offal on the supper surface of a beam, timber or floor boarding.

3. Test to be made which shall correspond as nearly as possible to the conditions likely to occur in case of fire in an establishment where there are moderate quantities of naphtha or other volatile substances which would generate a high degree of heat for a comparatively brief period.

4. Tests to develop the adhesive qualities and tenacity of the coatings, that is, what conditions will cause them to flake, peel or blister, and whether they are subject to such action under the ordinary conditions as found in practice.

These latter tests to include a time test, a moisture test and a heat test.

TIME TEST.—To be extended over a period of at least six months, the coated wood being subjected to normal conditions during that time, and also to such alternations of ordinary heat and cold as are practicable.

MOISTURE TEST.—Note to be taken of the hydroscopic condition of the surfaces during the previous tests, that is, whether moisture gathers upon them or otherwise, and samples of the coated wood to be subjected also to a steam bath of considerable duration to determine the effect on the coating, and whether after drying, its effectiveness is impaired.

HEAT TEST.—Samples of the coated wood to be subjected to conditions which would be met with in the ordinary dry kiln.

SUGGESTED METHODS FOR REDUCING LOCOMOTIVE FUEL CONSUMPTION.*

COMPOUND LOCOMOTIVES.—Compound locomotives are now in service in all parts of the country and in all classes of road service, and where skilfully operated have, we believe, demonstrated that they are fuel savers of from 15 to 25% as compared with single-expansion locomotives. In considering the advisability of the application of the compound principle to existing single-expansion engines, as one of the essential features in obtaining results from compounding is high pressure steam, and as a majority of the older single-expansion engines are not provided with boilers suitable for high pressures, it is doubtful whether economy would result in changing from single expansion to compound except in engines where the boilers are capable of sustaining at least 175 lbs. pressure per sq. in., and a higher pressure is desirable. If further economy by steam expansion and multiplying of cylinders be considered, it would seem proper to follow the lines suggested by a prominent engineer, who, while prophesying on the probable twentieth century improvements in locomotives, said: "We may all live to see triple, and even quadruple, expansion locomotives, almost noiselessly performing their work." This may be a hint to this Association to assist in the early development along these lines, and hastening the day of further economies by appointing a committee to investigate and report on the same.

FEED-WATER HEATERS.—Using the exhaust steam from air pump and cylinders for heating feed water, your committee looks upon as being one of the most promising directions in which to effect a reduction in locomotive fuel consumption. This feature can be applied to existing engines, as well as to new engines, with a moderate expense and but slight changes in existing arrangements, and is adapted to work in connection with several other fuel economizing devices, such as wide fire boxes, compounding, etc.

The average yearly temperature of water as delivered to locomotive tenders is from 50 to 60° F. For every 12° that the temperature of the feed water be raised by exhaust steam or waste gases before the water enters the boiler there will be a saving of 1% in fuel. If by the means recommended an average temperature of 200° for the feed water can be maintained, a saving of 12% in fuel would result.

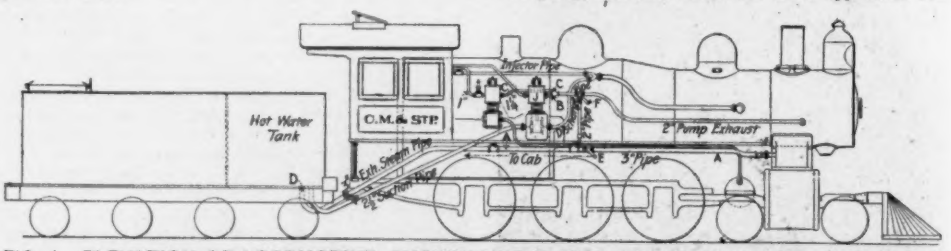


FIG. 1. ELEVATION OF LOCOMOTIVE, SHOWING PROPOSED ARRANGEMENT OF FEED-WATER HEATER.

The method we recommend for accomplishing this is illustrated in Figs. 1 and 2, and consists of a steam pump adapted to handle hot water. The exhaust from the air pump, water pump and a branch from the exhaust in front end, to be discharged into a portion of the tank, which we will designate as the hot-water tank.

The hot-water tank will have a capacity of 300 to 400 gallons of water. The partition will be water-tight, with the exception of a ½-in. space at the bottom, through which the water will maintain a constant level on both sides of the partition.

*Abstract of a report presented to the American Railway Master Mechanics' Association, at Saratoga, N. Y., June 18 to 20, 1901, by a committee consisting of A. E. Manchester, Chairman; A. Forsyth and A. F. Stewart.

The exhaust from the cylinder saddles is conducted to the rear of the engine through a pipe, as shown in Fig. 1 at A; and the exhaust from the water and air pumps, shown at B and C, joins this piping, which enters the bottom of the hot-water tank at D, and is then conducted up through the tank to the top and through a return pipe back to within two inches of the bottom of tank, where it terminates in a bell-shaped open end through which the exhaust escapes into the water.

In the exhaust pipe and between the pumps and cylinders is placed a shut-off gate at E, to close the exhaust from the cylinders to tank if desired; also a gate at F, where pump exhausts may be cut off from the tank and delivered to the front end.

The suction pipe for water pump is arranged to draw water from 4 ins. below the surface of the water in the

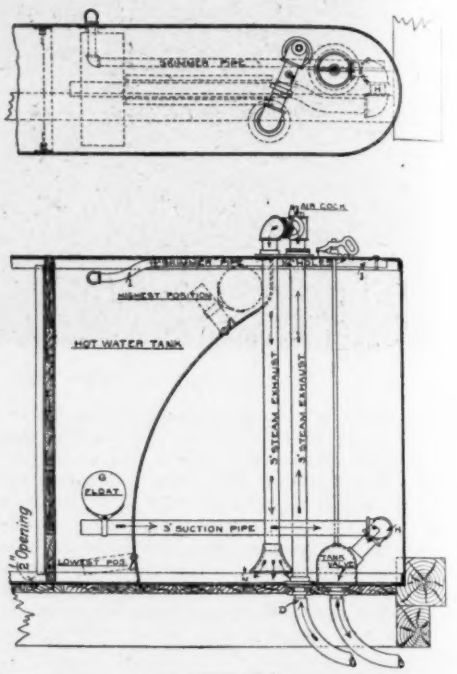


Fig. 2. Plan and Section of Hot-Water Tank, Showing Arrangement for Exhaust Steam.

water tank, the suction end being supported by a float or buoy, as shown in Fig. 2 at G, which rises and falls with the level of water in the tank. The other end of adjustable pipe connects with a flexible joint at H, and forms a connection through tank valve case in bottom of tank to hose and pump.

In the top of the hot-water tank is a perforated pipe, I, which connects to the pipe running down through the coal space to the under side of tender frame. When the tank is full of water this pipe acts as a skimmer to get rid of the oil coming in with the exhaust. It also acts as a safety valve for the escape of steam should the water in the hot-water tank get to a higher temperature than 212°, and thus prevent the hot water being forced out under the partition and into the cold water portion of tank.

The pump, hot-water tank and other appliances connected with same are on the right-hand side of engine and tender. The engine should be equipped with an injector large enough to supply the boiler when worked to its full capacity. The injector should be located on the right-hand side, but should take its water from the left-hand leg of tank. This arrangement should prevent the danger of trouble or delay on the road caused by the failure of the hot-water pump or any of the heating appliances, leaving the injector practically cold water to draw, should it be necessary to use same.

WIDE FIRE BOXES AND INCREASED GRATE AREA.—The first application of the wide firebox to the locomotive dates back a quarter of a century, but its use for a long time was confined principally to that section of the country using anthracite coal as fuel. Of late years the

...d of operation has extended, until to-day a majority ... engines for road service now building have this fea... Increased grate area is so closely allied to wide fire ... as to properly be considered in the same connection. ... a grate of more than 35 sq. ft. can hardly be ob... except with a wide fire box—and even this in a box ... in. wide or less puts the front portion of the grate ... from the fire door as to require a special effort and ...siderable skill on the part of the fireman to keep the ... grate covered—and as the fireman is one of the im...tant factors in fuel economy, in increasing the size of ... grate it should be done with a view of keeping all ...rtions within the reach of the average fireman, and at ... same time make the work of putting in the coal as ... as possible.

We are not prepared to recommend a definite proportion ... grate to cylinder or heating surface, or the relative ...idth to length; neither do we believe that such propor...tions can be correctly given and have them apply to all ...grades of fuel and classes of service. However, from in...formation received from those who have had the most ...xperience with wide fire boxes and increased grate area, ...and from reports of combustion tests showing the gas ...analyses of different sized grates and fire boxes, we feel ...warranted in placing this feature among the methods by ...which some improvement in fuel economy may be effected, ...but all the conditions should be carefully considered be...fore a radical departure is made from the deep and narrow ...box.

An uneconomical feature of the large fire box and in...creased grate area is the heating of unnecessary excess of ...air in the gases. This can be kept down to a minimum ...by careful firing and well fitting ash pans and dampers, ...if the latter be carefully manipulated. Adjustable grates, ...whereby the air space could be enlarged or decreased at ...will, might, if such a device could be made entirely reli...able, better perform this part, but we know of no grate ...that has withstood the test of service that will fill the ...requirements.

Another feature is the greater amount of coal that must ...be burned on a large grate while the engine is standing ...still and the greater care required to hold the steam below ...the popping-off point. The safety valve, if allowed to ...frequently perform its function, will be very wasteful of ...coal. This loss has been figured out as equal to ¼-lb. of ...coal per second, or a small scoopful per minute.

Wide fire boxes, when operating under favorable condi...tions and burning fuel suitable to their construction, will ...develop economies worthy of consideration; but in a ser...vice where much of the time is spent standing still and ...the fire is kept in a condition to go whenever the signal ...is given, enough fuel will be wasted while standing still ...to overcome the economies obtained while running.

INSTRUCTING ENGINEMEN.—Traveling engineers and ...firemen, light and intermittent firing, keeping a level fire, ...preventing excess of air in gases, perfect combustion, ...checking coal consumption each trip, and constant atten...tion to details, are some of the recommendations of mem...bers as the most promising directions in which to effect ...a reduction in locomotive fuel consumption.

REDUCTION OF CYLINDER CLEARANCE.—This is a ...recommendation of one member, in which he says:

> We have been experimenting on our line for some months with a valve motion, although the experiments up to date have been more to determine the wearing qualities of the valve motion rather than to determine the question of economy, and therefore we have not watched for economy of operation to the extent that we should perhaps otherwise have done; but in this work it has been demonstrated that with the valve motion mentioned the present clearance in the locomotive cylinder can be very materially reduced, and it would appear from experiments had in stationary practice that this will materially reduce the coal consumption, giving us in the locomotive the same intelligent distribution of steam that obtains to-day in the well-known Corliss type of stationary engines. The valve motion referred to is patented, and while it can be applied to existing locomotives, the best results will be had by applying it to new locomotives, or to locomotives receiving new cylinders, whereby the cylinder clearance will be reduced to a minimum, as is possible with the valve motion referred to.
>
> In this case it is represented that it is not only possible but practicable to reduce the clearance to 2%, while in the existing single-expansion locomotives the clearance varies from 4 to 10%. In a paper lately presented before one of the railway clubs, indicator cards were exhibited represented as taken from a cylinder having this valve motion and with 2% of cylinder clearance, the card showing a very satisfactory steam distribution.

ENGINES ADAPTED TO SERVICE.—This will prove ...economical, not only so far as fuel consumption is con...cerned, but in every other way. The operating of high-...speed trains with small wheel engines, running them at an ...excessive piston speed, or running large engines where ...smaller ones will do the work, will always prove expen...sive from a fuel standpoint.

UNIFORM GRADES OF COAL.—This is another impor...tant factor in fuel economy, especially when the grade of ...the coal varies and requires different treatment in both ...draft and firing. Coal of the same general grade should ...be furnished to a section or division and the engines kept ...where they will get but one grade.

LENGTH OF FLUES.—When it is considered that coal ...is the largest item of expense in the operation of a rail...road, and so long as 20 to 30% of the value of the fuel ...passes out of the smokestack as waste gases at a tempera...ture of 600 to 1,000°, it is natural that an investigation ...should turn in this direction with the hope of still further ...absorbing the heat from the gases, and that the length ...of the flue should be looked to as one of the possible ...means of doing so. From a fuel standpoint, what is the ...economical length of a 2-in. flue? Your committee is not ...prepared to furnish any information on this point, but ...feels that it is a subject worthy of a very thorough and ...careful investigation.

One of the unfortunate conditions under which this ...Association works is that of being unable to make appro...priations for carrying on scientific investigations of sub...jects of vital interest to all railroads. It is to be hoped ...that in time the powers controlling the railroad purse ...strings will undergo a change of heart and find that it ...will be to their interest to furnish a pro rata amount suffi...cient to enable the Association to hire experts to conduct ...researches along important mechanical lines. Action of ...this kind would prove economical to the individual rail...road by relieving it of the expense incurred in making ...individual research, and by furnishing to all railroads a ...central source of authority to which they can turn for ...information, thereby making the American Railway Mas...ter Mechanics' Association a far stronger society in the ...eyes of the world. Let us hope that these conditions may ...come to pass.

There are those here who can remember when 10 or 11 ...ft. was the maximum length for a locomotive flue. To...day from 16 to 18 ft. is quite common practice in new ...engines, and 19 ft. has lately been tried; yet, so far as ...we know, the Association or the members of same are not ...satisfied as to whether the economical length for a 2-in. ...flue has been reached.

SUPERHEATING.—Superheating of steam is much in ...favor in stationary practice in Europe, and is beginning ...to receive considerable attention in this country. We un...derstand that to some extent efforts have been made to ...apply the principle to locomotives with economical re...sults, and that tests are now under way in this country ...along the same lines. If its application to locomotives ...can be made entirely practicable, it may be one of the ...means of determining the economical length of the flue; ...but both these points are worthy of consideration and ...might furnish a fit subject for the special investigation of ...one of your committees.

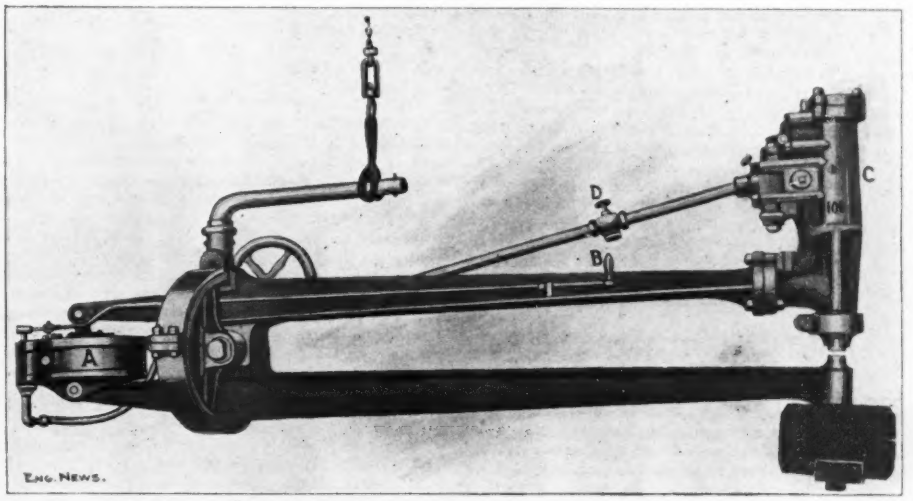
BATES FIRE DOOR, ETC.—Bates fire doors, Master ...Mechanics' front ends, outside lap and no lead on valves, ...coarser netting and large nozzles, and piston valves have ...also been suggested to your committee as means by which ...saving in fuel might be effected.

AUTOMATIC STOKERS.—Automatic stokers are being ...used for a double purpose. It is expected by those per...sonally interested that economical results in the use of ...fuel will be obtained, and at the same time the labor of ...the fireman will be considerably lightened, requiring less ...effort and skill on his part to feed and operate than when ...doing the work by hand. We mention it as a line which ...is receiving some consideration, and may in the near ...future present some desirable features in connection with ...the use and handling of fuel on locomotives.

The largest type of locomotives, except they be equipped ...with some means for reduction of fuel consumption, have ...reached the limit of the ability of the average fireman to ...satisfactorily feed the furnace and keep up the maximum ...steam pressure. The question of the cost of fuel should ...not alone be considered; it is necessary that fuel-econo...mizing devices be applied to save the fireman, and we ...believe that the possibilities along this line are such as to ...warrant your committee in saying that it is practical to ...apply and successfully operate on the locomotive, fuel ...economizing features that will so far reduce the amount ...of fuel burned and the labor of handling same as to not ...require the full strength of the average fireman to keep ...up the maximum pressure of steam with the engine oper...ating at its full capacity.

A PNEUMATIC HAMMER RIVETER WITH POWER GRIP.

We illustrate in the accompanying cut a pneu...matic hammer riveter for boiler work which has ...the novel attachment of a pneumatic cylinder for ...closing the jaws and clamping the work during ...the heading of the rivet. The construction and ...operation of the machine are quite obvious from ...the illustration. Briefly described, the machine ...consists of two levers hinged together like the ...blades of a pair of shears, having at one end a ...pressure cylinder to open and close the levers, ...and at the other end a pneumatic hammer riveter ...on one arm and a suitable die, with counter...weight, attached to the other arm. To operate ...the machine, the rivet boy, after inserting the ...hot rivet, moves the die and weight over the head ...of the rivet. The operator then admits air into ...the pressure cylinder A by moving the rod B, there...by closing the long ends of the lever arms and ...pressing the hammer nozzle upon the plates over ...the rivet. The closing pressure is about 3,000 lbs. ...Air is then admitted to the hammer C by pressing ...the spring valve D. The hammer performs the ...heading operation by a succession of rapid blows—...from 150 to 200 per minute. It is stated by the ...builders of the machine that the time required ...to form the head of a ¾-in. rivet is about six ...seconds, and that at steady straight work, allow...ing for ordinary detention and loss of time, two or ...three rivets can be placed and headed in one min...ute. It is also noted that the hammer valve is ...operated directly by pressure within the cylinder, ...and is so arranged that the length of the stroke ...regulates itself automatically to correspond with ...the gradual reduction of the end of the rivet, as ...the head is formed. The hammer is operated un...der an air pressure of 30 lbs. to 40 lbs. The ma...chine illustrated is built by the Allen Pneumatic ...Machine Works, 370 Gerard Ave., New York city. ...We are indebted to Mr. John F. Allen of these ...works for the information from which this de...scription has been prepared.



PNEUMATIC HAMMER RIVETER WITH POWERGRIP.
Allen Pneumatic Machine Works, New York City, Builders.

ANNUAL CONVENTION OF THE AMERICAN WATER-WORKS ASSOCIATION.

The twenty-first annual meeting of the association was ...held in New York city, June 17 to 21. The registered ...attendance was larger than usual, and the meeting as a ...whole was above the average for recent years.

After the usual speeches of welcome, the presidential ...address was presented by Mr. C. E. Bolling, of Richmond, ...Va. President Bolling spoke briefly and directly to the ...question, what do these annual gatherings mean and what ...is gained from them? He reviewed the many and varied ...qualifications of the successful water-works manager, ...which often include a knowledge of architecture, civil and ...mechanical engineering, chemistry, bacteriology and met...allurgy. Besides all these things, such officials must have

marked business ability and must stand ready to act as arbitrators between the city and contractors, the water department and the consumer. The American Water-Works Association is an important aid in fitting a man to fulfil these various requirements.

WATER-WORKS DISTRIBUTION.

The first paper to be presented to the association consisted of an outline by Mr. Chas. A. Hague, M. Am. Soc. C. E., of the principles involved in designing the distribution system of water-works. A division of the city into districts was suggested, with a detailed study of the needs of each section. The free use of pressure recording gages on existing systems was recommended. A minimum diameter for mains of 6 ins., with 8 ins. as preferable in most cities, was named for distributing systems. All that is saved in pipe, by using the smaller sizes, is soon lost in increased pumping expenses. There was no discussion on this paper.

ELECTRICALLY DRIVEN CENTRIFUGAL DEEP WELL PUMPS, USED AT MOSCOW, RUSSIA.

This paper was prepared by Mr. Nicholas Simin, Chief Engineer of the Water-Works of Moscow, and was read by Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E. It included a historical description of the works, and an outline of improvements in progress and proposed. The population of Moscow is about 1,000,000. The city has an area of about 30 square miles. A public water supply was introduced in 1779, drawn from springs a number of miles from the city. In 1890-2 driven wells were put down in the vicinity of the springs. A pumping plant was erected and water was forced through a 24-in. main 8½ miles long to an underground reservoir of 3,250,000 gallons capacity. From this reservoir the water is again pumped to elevated reservoirs in the city.

The water consumption of Moscow in November, 1900, was only 5,000,000 gallons a day, but about that time sewers were put in use. When the sewers are completed a consumption of 56,000,000 gallons is expected. Reliance will be placed on the springs and wells for 11,000,000 gallons a day and 45,000,000 gallons more will be taken from the Moscow River and purified.

To increase the yield of the 20 new 16-in. wells a centrifugal pump will be placed in each and driven by direct-connected motors, located in pavilions over the well. Of the 20 pumps six will be held in reserve. The centrifugal pumps will deliver water into four equalizing reservoirs, from which pumping engines will force water to the underground reservoir already mentioned.

The new river water supply was begun in September, 1900. It will be built in four sections, each having a capacity of a little over 11,000,000 gallons a day. Experiments on a working scale, beginning with a 3,000,000-gallon slow sand filtration plant, will be made to determine the system of purification best adapted to the river water.

WATER PURIFICATION BY MEANS OF OZONIZED AIR.

This paper also was sent by Mr. Simin and read by Mr. Trautwine. The author seemed to be very favorably inclined to the ozone treatment. He had visited some experimental plants in Europe. He stated that ozonized air burns all organic matter in the water, including bacteria, and that water so treated will remain sterile a long time, because there is no food left for the development of more germs. If the suspended matter is removed before the ozonized air is applied, it will not matter how many bacteria are present; all will be killed. The cost of this process was given by Mr. Simin as $6.25 per 1,000,000 gallons, not including preliminary treatment for the removal of suspended matter. The author suggested that the preparation of the water for ozonization might be effected by means of mechanical filters, using a small amount of coagulant.

The discussion on this paper was opened by Mr. Geo. W. Fuller, Assoc. M. Am. Soc. C. E. He believed there was no doubt but that pathogenic bacteria might be removed by ozonized air, but the commercial practicability of the process seemed doubtful.

Mr. Allen Hazen, M. Am. Soc. C. E., said that the process could never take the place of sedimentation and filtration, but must be auxiliary, simply removing the relatively small numbers of bacteria remaining after those processes had been employed, together with the odor, and, if enough ozone was used, the color. Mr. Geo. A. Soper, Assoc. M. Am. Soc. C. E., referred to his own studies of this subject abroad and his experiments at home.* He thought the paper was an admirable review of the ozone process. He believed quite a degree of preliminary purification must be effected in order to remove both organic suspended and coloring matter, because otherwise these substances will absorb large amounts of the ozone before the ozone will attack the bacteria. Since the water must be clarified before ozonization, and since the clarification will remove a large portion of the bacteria, the process seems to be of doubtful applicability, save under exceptional circumstances. In general, he believed an average of $10 per 1,000,000 gallons would be required for power to generate the necessary ozone. He did not think anyone had figured the total cost of the process, including labor and capital charges.

Mr. C. Monjeau was of the opinion that ozone "destructs but does not destroy." What he wished to convey was that the microbes were simply reduced in size. Mr. Soper explained that even though the bacteria were merely "destructed" and reduced to smaller sizes, the "destroyed" remains were simply mineral ash, devoid of life.

*For discussions of this subject by Mr. Soper and others see Engineering News, July-Dec., '99, pp. 250, 256, 340.

THE ALBANY FILTRATION PLANT AND SOME OF THE RESULTS OBTAINED.

Mr. Geo. I. Bailey, M. Am. Soc. C. E., read a paper with this title, the greater part of which will be found elsewhere in this issue. Mr. J. M. Diven remarked that slow sand filtration, as now conducted, seemed un-American, and that the time will come when Yankee ingenuity will devise a better means of cleaning filter beds than that now in vogue.

PURIFICATION OF THE CHEMUNG RIVER AT ELMIRA, N. Y.

This paper gave the results obtained by mechanical filtration at the works of the Elmira Water Co. It was prepared and read by Mr. James M. Caird, of Troy, N. Y., Chemist and Bacteriologist in charge of the filter plant. An abstract of the paper will be found in another column of this number. The two foregoing papers were illustrated by lantern slides. After their presentation Mr. Allen Hazen, M. Am. Soc. C. E., showed a few slides relating to water filtration.

A SYMPOSIUM ON WATER CONSUMPTION AND THE USE OF METERS.

Three excellent papers on this general subject, but varying much in plan and scope, were presented by Messrs. Clemens Herschel, S. J. Rosamond and H. C. Hodgkins. More complete abstracts of these papers than could be included in this report are given in an article elsewhere in this issue, with which we have combined an account of the interesting discussion which followed the papers. We have also commented on this same subject on the editorial page.

SHOULD FIRE HYDRANTS BE USED FOR FILLING SPRINKLING CARS AND WAGONS?

A query, or number of queries, relating to street sprinkling by railway companies gave rise to quite an extended discussion on the use of fire hydrants for any other purposes than fire protection. Aside from those officials who make use of a special valve attached to one of the nozzles of a double hydrant, nearly every one who spoke on the subject protested emphatically against the use of fire hydrants for filling sprinklers, or for any other than fire purposes. At Memphis, Tenn., trolley sprinkling cars were formerly filled from hydrants placed between the railway tracks, with their tops flush with the street surface. Latterly the city has done its own sprinkling, and used whatever hydrants it saw fit. The discussion showed a strong tendency to make a low charge for water used by street sprinkling contractors.

A SKEPTIC'S EXPERIENCE WITH MECHANICAL FILTERS.

The author of this paper, Mr. J. M. Diven, of Elmira, N. Y., said that when he first saw a model of a mechanical filter at St. Louis, Mo., years ago, converting turbid water into a clear and sparkling liquid, his apprehensions were aroused. He feared that if the public in any way got the idea that clear water could be substituted for muddy there would be a demand for the former, regardless of the practicability of the process. He has since become convinced of the practicability of mechanical filtration (a plant has been installed at Elmira), and of the commercial value of pure water. The latter being what the people wish, its provision means increased sales. He believed that as good sanitary results could be secured by mechanical as with slow sand filtration, and that the latter, as compared with the former, is much like a ponderous Cornish steam pump alongside a modern high-duty pumping engine. The chief points in favor of mechanical filtration, to Mr. Diven's mind, are as follows:

(1) It is an American idea; the result of Yankee ingenuity, and should be encouraged.

(2) Compactness, accessibility and ease of management of the plant. The sand can be sterilized by steam. At Elmira each filter tank is so sterilized once in nine weeks, and, in addition, after every run with particularly bad water.

(3) Ease of meeting varying conditions.

(4) The ease and simplicity of washing favors frequent cleansing of the filtering material, instead of postponing that operation as long as possible.

(5) The small units employed render it unnecessary to cut out a large part of the plant whenever cleaning or repairs are necessary.

An advantage of slow sand filtration, on the other hand, is the permanency of the plant; but its greater first cost results in high capital charges.

In answer to a question, Mr. Diven said the cost of filtration at Elmira is $3.50 per 1,000,000 gallons, including interest and depreciation. The plant is some distance from the pumping works, thus requiring an independent filter crew. Mr. Dow R. Gwinn said the cost of mechanical filtration at Quincy, Ill., is $1.63 for coagulant and $1.63 for other expenses, making $2.80 per 1,000,000 gallons, not including capital charges.

MATTOIDS IN ENGINEERING.

This paper was by Mr. H. F. J. Porter, M. Am. Soc. M. E., of the Bethlehem Steel Co. The author pointed out the tendency of the day to accept statements, scientific and otherwise, without question, much as a dog swallows meat without digestion. Unfortunately, men of this class are often placed in responsible positions, where their undigested ideas and an undue confidence in their own knowledge leads them to make errors that may cause the destruction of both life and property. As illustrations the author cited some erroneous ideas held by officials whom he had met relating to the advantages of steel over cast-iron shafts and hollow tempered steel axles and shafts as compared with the ordinary solid shafts. He also urged upon the association the desirability of joining in the work of the International Association for Testing Materials.

THE WATER-WORKS DISTRIBUTION OF ST. LOUIS, MISSOURI.

An interesting paper on this subject was read by Mr. Benj. C. Adkins, of St. Louis, who has been connected with the distribution system named ever since 1886. The present carrying capacity of the mains in the business district of the city is equivalent to 6.2 mains, each 30 ins. in diameter. The aim is to place valves so the average shut-off will not extend over five blocks throughout the city and not more than two blocks in the business districts. There are 11.48 hydrants per mile of main in the business section. Of 1,780 hydrants repaired in one year, 353 were out of order on account of having been used to fill sprinkling carts.

WATER-WORKS ARBITRATION.

The secretary, Mr. Peter Milne, reported that in accordance with instructions given him at the last convention he was preparing an abstract of arbitration cases involving differences between water companies and cities. He had found one very grave cause of trouble, namely, the failure of companies to frame their rules and regulations in strict accordance with the provisions of their franchises. Mr. Milne was given an extension of time for the completion of his review of this subject, with the understanding that he would publish the results in a separate pamphlet, to accompany the proceedings of the convention.

REPORT OF SPECIAL COMMITTEE ON ELECTROLYSIS.

The report of this committee, in accordance with a vote of the association, was printed in the Proceedings for 1900. The convention just held adopted the resolutions recommended by the committee (composed of Dabney H. Maury, G. H. Benzenberg and J. Waldo Smith). We have reprinted the resolutions, with brief comment, in our editorial columns.

OTHER COMMITTEE REPORTS AND THE APPOINTMENT OF NEW COMMITTEES.

Two committees with very long titles which have been in existence for some years past, were discontinued. The object of one committee was to memorialize Congress to take action against stream pollution; the other was appointed to secure the enlargement of the powers of state boards of health in the matters of water supply and drainage. Mr. C. Monjeau has been the most active member of each committee, and was present with a voluminous report, purporting to be on behalf of the last-named; but the other members of the committee, Messrs. John Caulfield, Chairman, and H. C. Hodgkins, presented a very brief report dissenting from the opinions expressed by Mr. Monjeau. They particularly disagreed with expressions in that document which seemed to reflect on the efficiency of most boards of health and of modern systems of water purification. Mr. Monjeau's report was referred to the Committee on Publication. It was voted to accredit Mr. Monjeau as a representative of the association at the meeting of the American Public Health Association, in September next.

New committees were appointed as follows: On Permanent Headquarters, J. B. Cleaver, John C. Kelley and Edmund Mather; Uniform Specifications for Cast-Iron Pipe and Special Castings, J. J. R. Croes, H. F. J. Porter and Peter Milne; Uniform Statistics, Reports and Accounts, Dow R. Gwinn, John C. Trautwine, Jr., and Emil Kuichling. The last two committees were authorized to confer with similar committees from other societies.

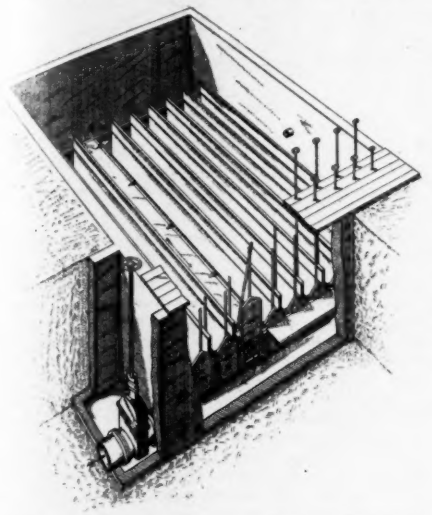
Chicago was chosen as the next meeting place. Mr. Wm. R. Hill, M. Am. Soc. C. E., Chief Engineer of the Croton Aqueduct Commission, was elected president, and Mr. Peter Milne, Assoc. Am. Soc. C. E., Bennett Building, New York city, was re-elected as secretary.

The members and guests of the association were handsomely entertained by the Committee on Arrangements. Among other trips a visit to the new Croton dam was made. The whole of Saturday was devoted to the journey which was made by boat to Croton Landing, and thence by carriages. The work on the dam was begun in 1892 and is still far from complete.

There were a number of exhibits on the part of associate members, as noted in the supplement in this issue.

A METHOD OF CLEANING SETTLING RESERVOIRS WHILE IN USE.

The accompanying illustration shows a method of removing the deposit from settling basins or reservoirs without throwing them out of use. It will be seen that a series of partitions, provided with hinged covers, is placed in the bottom of the reservoir. The compartments thus formed are open at one end and closed by gates at the other. When it is desired to clean the reservoir, the shutters of one or more compartments are dropped and the corresponding gates are lifted. The head



Sketch of Method for Cleaning Settling Reservoirs While in Use.

of water forces the sediment out through the gates into the waste channel and pipe shown in the cut. A patent on the device was granted on April 23 to Prof. W. P. Mason, of Troy, N. Y. We are indebted to Professor Mason for information relating to his invention.

THE PASSAIC VALLEY SEWAGE-DISPOSAL INVESTigation, it is reported, will proceed at once. It is said that Mr. Jas. Owen, M. Am. Soc. C. E., of Newark, N. J., will have charge of the preliminary work on the Lower Passaic, and that the work on the Upper Passaic will be carried on by the engineers named in our issue of June 20 (p. 441). The preliminary studies, it is supposed, will be submitted to a board of experts. It is hoped that the State Sewerage Commission will have something definite to report to the state legislature of 1902. The Newark Board of Trade is talking of employing engineers to make an independent study of the problem.

WIRELESS TELEGRAPHY is being experimented with by the Pere Marquette Ry. for use on the vessels operated by the company on Lake Michigan. The tests are being conducted by Mr. Joseph W. Schwab, President of the Northwestern Wireless Telegraph & Telephone Co., of Chicago; Prof. Warren Johnson, of the Johnson Electric Service Co., of Milwaukee, and W. L. Mercereau, Superintendent of the Pere Marquette Ry.

AN INDUSTRIAL, AGRICULTURAL AND MINING exhibition will be opened at San Juan, Argentine Republic, on July 9. Firms constructing machines and apparatus employed in agriculture, mining, etc., are invited to exhibit.

THE OPERATIONS OF THE ALBANY SLOW SAND FILTRATION PLANT TO THE CLOSE OF 1900.

Ever since the Albany filtration plant was put in operation on July 26, 1899, all eyes have turned in that direction with the belief that in due time some valuable figures as to cost of operation and sanitary results would be forthcoming. In our issue of Aug. 9, 1900, we published an article by Mr. Geo. I. Bailey, M. Am. Soc. C. E., Superintendent of the Bureau of Water, in which he presented in detail the first installment of the expected figures relating to the working of the filters up to July, 1900. At the meeting of the American Water-Works Association last week, Mr. Bailey read a paper embodying the operations of the purification works from their inauguration to the close of 1900. The figures given in that paper were not only for a longer period than was covered by the earlier statement, but they were more comprehensive in some particulars. Following as Mr. Bailey's review does, close upon the recently-published information as to filtration at both Lawrence, Mass., and Mt. Vernon, N. Y.,* its value is enhanced by its timeliness.

Mr. Bailey opened his paper by outlining the need for detailed figures relating to the operations of filtration plants which confronted him when the Albany purification works were put in operation. The relatively few figures of cost of operation then available were lump figures, and we may add were suspiciously low, if designed to cover everything. Mr. Bailey also called attention to a misleading feature of the German standard of 100 bacteria per cu. cm. for filtered water. Some 50 experiments at Albany have shown that the German methods of bacterial analyses yield only one-half as many germs in a given water as is shown by American methods. He next proceeded to describe the Albany plant. It is only necessary to say here that the water is pumped from the Hudson River to a settling basin. The total lift is 18 ft. From this basin it passes by gravity to and through eight covered filtered beds, each having an effective area of 0.7-acre. The normal rate of filtration is 3,000,000 gallons per acre per day. From the filters the water passes by gravity to an adjacent covered clear water reservoir and thence to the main pumping station. When a bed is first put in operation, after scraping, the rate of filtration

is seldom more than 1,000,000 gallons per day, which is increased by from 100,000 to 200,000 gallons every four hours, and the full rate is not permitted until the thickness of the top layer creates a friction head of 5 ins., after which the full rate is maintained until the friction head is 4 ft., when the filter is laid off for cleaning.

While scraping, the men wear wooden sandals, 5 × 18 ins. The balance of Mr. Bailey's paper is given in full, with the exception of a table of total deaths, and deaths from diarrhoeal diseases for the past eleven years:

OPERATIONS.

The various operations have been classified in accordance with the work done, as follows:

SCRAPING BEDS.—Includes the removal of covers from the manholes in the roof and scraping into piles the sediment layer composed of silt and bacteria, together with some filter sand.

WHEELING OUT.—Includes the placing, changing and removing of the running plank, shoveling the scraped material into wheelbarrows and removing it to the court, raking and screeding the bed and replacing the manhole covers. The average round-trip distance for removing sand is about 500 ft.

WASHING.—Includes the handling of scraped sand from the storage piles to the sand washer, attendance to the sand washer and removing the washed sand to a storage pile.

REFILLING.—Includes removal of washed sand from storage piles into the filter by wheelbarrows, loosening top layer of old sand to a depth of about 6 ins., leveling the new sand, placing and removing running plank, and all other incidental work. This is chiefly done by extra labor. The average round-trip distance from storage piles to filter is about 600 ft.

LABOR IN PUMPING STATION.—Is that furnished for removing ashes from boiler room, cleaning floors and walls, and such other incidental work inside the station as the engineer may demand.

LABOR IN LABORATORY.—Is in gathering samples of water, cleaning utensils, and such other services as the chemist may require.

INCIDENTALS.—Is the general work of caring for grounds, grass cutting, snow removing, cleaning out sedimentation basin, repairing roads, repairing tools, etc.; one-half is charged, each, to pumping plant and the filter beds.

LOST TIME.—Is that for which the city pays, and in which no work is done, due to absence through sickness caused by the work, stormy weather, etc., and its cost is divided pro rata among all other classes of labor.

SUPERINTENDENCE.—Includes the wages of permanent foreman, extra foreman when needed or appointed, and the wages of a night watchman. This is divided pro rata among all the grades of labor.

WASH WATER.—This is for the water used for washing the sand scraped from the beds. We have found that the proportion of water is 12½ parts to 1 part of washed sand. We have charged this water at 1.2 cts. per 100 cu. ft., which is a little more than it costs the city to filter the water and pump it into reservoirs, and which is equivalent to a charge of 4 cts. per cu. yd. of washed sand.

*"The Lawrence, Mass., City Filter," by Morris Knowles, Assoc. M. Am. Soc. C. E., and Chas. G. Hyde, C. E., Proc. Am. Soc. C. E., April, 1901; and "Six Years of Slow Sand Filtration at Mt. Vernon, N. Y.," Eng. News, May 30, 1901. Some of the figures in the Lawrence paper were given in our issue of May 30. The design and construction of the Albany plant were described at length in our issues of Feb. 10 and Oct. 20, 1898.

TABLE I.—Deaths from Typhoid Fever at Albany, N. Y., Before and Since the Introduction of Filtered Water.

(From records of Board of Health, State of New York.)

Year.	Month												
	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Total.
1890. ...	13	5	4	6	2	5	1	7	6	3	4	6	62
1891. ...	20	27	15	9	7	2	3	5	4	4	3	9	108
1892. ...	4	5	7	4	1	..	3	4	3	4	10	5	50
1893. ...	4	5	9	10	4	2	1	6	2	5	3	7	58
1894. ...	7	5	10	3	4	6	2	6	3	1	1	4	52
1895. ...	6	17	26	27	13	9	10	6	8	6	13	21	162
1896. ...	25	12	17	4	3	6	6	6	9	5	3	1	97
1897. ...	7	9	7	8	3	4	5	9	10	6	8	8	84
1898. ...	12	8	8	4	3	1	3	20	12	5	7	11	94
1899. ...	14	12	14	13	3	9	2	4	•2	•4	•..	•1	80
Total..	112	105	117	88	43	44	36	73	59	43	52	73	837
A'v'ge ..	11	11	12	9	4	4	4	7	6	4	5	7	84
1900.* ..	3	1	3	5	4	1	3	6	4	5	4	..	39

*Filter in operation.

RESULT ON PUBLIC HEALTH.

The true measure of the efficiency of a filter is the effect on public health and the reduction of deaths from certain unmistakable water-borne diseases, as well as a general betterment in health conditions. The tables show comparisons between the year 1900, being the one calendar year that the filter has been in operation, and the previous ten years' records, although in the four last months of the year 1899 the filter was in operation, and the general average has the benefit of any decrease for those four months.

In making comparisons, it should be borne in mind that the only general improvement in sanitary conditions in our city has been the installation of the filter plant, and all tables show a reduction in death rates coincident with the operation of the filters.

In the monthly bulletin for December, 1900, issued by the State Board of Health of New York, occurs the following:

The number of deaths from all causes reported for the year exceeds the mortality of 1899 by 6,647, and the average of the past five years by 8,000. The increase over last year has been in all the sanitary districts except those of the central and southern parts of the state.

Typhoid fever was unusually prevalent in the autumn, causing 1,948 deaths, 350 above the average.

Diarrhoeal diseases raised the average mortality, * * * notably increasing the late summer and autumn mortality of the rural parts of the state rather than the urban.

The above statements indicate, then, that there was an excessive mortality throughout the state, and that comparisons of the year 1900 with the average of previous years for this city does not give the advantage to the one year that rightly accrues to it. Notwithstanding this condition, we find that while the average number of deaths for ten years in Albany has been 2,186, the number of deaths for the year 1900 was only 1,742, a decrease of 444 deaths, indicating generally a better condition of health.

Typhoid fever and sewage polluted water are almost synonyms, still typhoid fever does come from other sources than an impure water supply, and in the present year in our city three deaths and about twenty cases have been traced to an impure milk supply. The general and common cause of it in cities and villages is, however, an impure water supply.

By the typhoid standard the Albany plant has been proven an immediate and certain success. The average yearly deaths from this cause for ten years (including four months of filter use) has been 84. The number of deaths last year was 39. Of these 39, 14 were unmistakably alien or imported cases, for which the city's condition is not responsible. In previous years, when an epidemic of typhoid has occurred up stream either in Troy or Cohoes, an increase of cases has occurred in Albany. The last year was an exception to this rule, and

TABLE II.—Summary of Bacterial Efficiency of Albany Filtration Plant.

Month.	Bacterial count						Average removal, %
	Raw water.			Pure water			
1899.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	
September. ..	20,300	10,200	16,800	800	244	343	97.6
October	21,000	2,500	10,700	267	37	142	98.6
November ...	21,000	3,400	9,200	115	35	71	99.2
December ...	80,200	16,800	45,800	450	98	213	99.4
1900.							
January	124,000	37,500	66,300	3,500	225	1,232	98.3
February	230,000	69,000	119800	2,925	160	938	99.2
March	120,000	17,000	44,700	732	200	426	98.8
April	49,000	4,500	26,000	165	54	80	99.6
May	6,400	1,400	2,600	74	20	35	98.6
June	6,700	1,400	3,100	85	25	45	98.4
July	12,000	1,200	3,500	45	19	32	98.6
August	7,800	1,100	3,400	30	18	23	99.1
September. ..	8,400	1,300	5,000	35	18	24	99.4
October	8,000	2,100	18,500	40	19	25	99.4
November ...	55,000	2,250	47,800	200	85	93	99.3
December ...	75,000	16,000	63,700	320	125	232	99.5

TABLE III.—Gross Cost of Operating Albany Filter Beds, July 29, 1899, to Dec. 29, 1900.

Labor	$6,131.63
Incidentals (50% of all)	574.92
Lost time	451.32
Superintendence (91% of all)	2,161.43
Supplies	552.25
Supplies, miscellaneous (84% of all)	604.84
Wash water	226.92
Total	$10,703.31

TABLE IV.—Detailed Cost of Operating Albany Filter Beds, July 29, 1899, to Dec. 29, 1900.

Items.	Time spent—Hours.	Time spent—Pr ct. of total.	Total cost.	Unit cost—Per million galls.	Unit cost—Per acre.	Unit cost—Sand, yds.
Scraping	5,481	14.63	$1,532.70	$0.24	$12.37	.....
Wheeling out	10,238	27.33	2,863.20	.45	23.11	$0.36
Refilling	7,437	19.87	2,081.06	.32	.....	.37
Incidentals*	3,009	8.03	841.25	.13	.....	...
Lost time	2,365	6.32	662.10	.10	.....	...
Washing	8,923	23.82†	2,722.40	.42	.....	.48
Total	37,453	100.0	$10,703.31	$1.66	.....	...

*50%. †Plus wash water.

notwithstanding decided increases in both, Albany decreased 54% in its number of deaths. (See Table I.)

Another group is of "diarrhoeal diseases." Diarrhoeal mortality is not based upon so limited and direct causation as that of typhoid fever, which is only exceptionally due to anything other than infected drinking water, while in diarrhoeal cases the mortality in early life is greatly affected by season, improper food and the healthfulness of surroundings or lack of it. Water-borne filth germs are a cause as well; they have a greater vitality in water than the typhoid bacilli, and they reach the intestinal tract in the same way, and while diarrhoea and dysentery are not limited to the operation of such specific germs as are typhoid or cholera, they may be caused by any germs which attend the decay of organic matter. I think it fair that the filters should be credited with the decrease in mortality from this cause. The average number of deaths from diarrhoeal diseases for ten years (including four months of filter use) has been 120. Last year the number was 70. The decrease is therefore 42%.

BACTERIOLOGICAL AND CHEMICAL.

The customary method of judging the efficiency of a filter is by a count of the bacteria in the raw water and of those remaining in the water after being filtered, and thus obtaining the percentage of removal. This gives a quick knowledge of what is being done, and affords an opportunity for correction or changes and improvement in operation and manipulation. This method is a necessity, and a filter plant without it is like a ship without a rudder.

Table II. shows by months the work accomplished, and that for the year the average bacterial removal has been over 99%.

All stream waters contain substances other than the elements which form water. Some of these properties are in solution and can only be determined by careful chemical analysis. The results of such analyses, together with a full history of the surroundings of the stream, give a good knowledge of the potability and healthfulness of the water. Sand filters remove some of these soluble matters, and of the most objectionable of them the average removal has been found as follows, all quantities being given in parts per million:

Albumenoid Ammonia: Raw water	0.3053
Filtered water	0.1566
Removal	49%
Free Ammonia: Raw water	0.1117
Filtered water	0.0245
Removal	78%
Carbonaceous matter, measured by required oxygen: Raw water	6.10
Filtered water	4.35
Removal	29%
Color (platinum standard): Raw water	.37
Filtered water	.28
Removal	24%

The turbidity of the raw water, as measured by the platinum wire scale, averages 0.080. Practically it is all removed, and even when the river is in its most turbid and rolly condition the filtered water shows only a slight opalescence, which, when measured, comes within the aesthetic limits determined by experts at Pittsburg, Philadelphia and Washington.

In addition to these determinations, counts of bacteria coli communis have been made to show their relative frequency in the unfiltered and filtered water. In the raw water coli was found in 30 out of 32 samples, the number of colonies varying from 2 to 35, the average being 9. In 43 samples of filtered water coli was found in only 7; 5 of these had 1 colony only, 1 had 2 colonies, and 1 had 3 colonies. The methods for making the count were as recommended by the State Board of Health of Massachusetts.

TABLE V.—Details of Filter Plant Operations at Albany, Including Filter Beds, Care of Grounds, Pumping Station, and Laboratory.

Date, from and to	1899. 7/20 to 12/29	1900. 12/30 to 9/30	Total.	1900. 9/30 to 12/29	
No. of days	137	182	319	182	
Scraping beds: No. of beds	28	49	77	50	
Hours	1,317	1,914	3,231	2,250	
Square yards	.....	.....	261,954	.....	
Wheeling out: Hours	2,415	4,073	6,488	3,750	
Barrow loads	25,179	46,523	71,702	28,443	
Cubic yards	1,190	3,700	4,890	3,052	
Washing sand: Hours	2,071	4,257	6,328	2,595	
Barrow loads	18,262	43,949	62,211	21,088	
Cubic yards	850	2,643	3,493	2,180	
Refilling beds: Hours	1,631	3,473	5,104	2,333	
Barrow loads	18,550	41,040	59,500	29,441	
Cubic yards	850	2,643	3,493	2,180	
Labor, hours' work: Engine room	608	1,456	2,064	2,107	
Laboratory	172	198	370	65	
Incidentals	584	2,725	3,309	2,708	
Lost time	567	1,329	1,896	469	
Total	9,365	19,425	28,790	16,279	
Paid (pay roll): Labor	$1,887.26	$3,677.73	$5,564.99	$3,048.06	$8
Superintendence	528.65	863.93	1,392.58	982.62	
Chemist	499.98	499.98	999.96	499.98	
Pumping station	.....	.....	4,258.65	2,429.70	
Paid bills: Pumping station	.....	.....	4,298.53	3,845.59	
Filter beds	.....	.....	317.75	234.50	
Laboratory	.....	.....	245.15	144.50	
Miscellaneous	.....	.....	609.50	110.54	
Wash water—12½ to 1 of washed sand	.....	.....	139.72	87.20	
Total cost	.....	.....	$17,826.83	$11,382.69	$29
Gallons filtered (1 = 100 000)	1,612.5	2,204.7	3,817.2	2,645.8	
Average gallons filtered daily (1 = 1,000)	11.770	12.114	11.966	14.537	
Cost per million gallons	.....	.....	$4.67	$4.30	

OPERATION COST.

Filter plants vary in arrangements and appurtenances. Some have to pump water upon the beds, as at Poughkeepsie, West Superior and Albany. Others get the water by gravity, as at Somersworth, Ilion and Lawrence. So far as the writer knows no American plant, except Albany, has a permanently employed chemist in charge. To make comparisons of cost, therefore, it is necessary that the expense should be divided to show separately the cost of filtering, the cost of pumping and the cost of chemical work. The unit of cost is for 1,000,000 gallons of water treated.

The cost of filtering at Albany has been $1.66. Table III. shows the gross cost of operating the filter beds, and Table IV. subdivides the cost and shows the proportionate charge for each of the operations, as scraping, washing sand, refilling, etc. The gross cost for all operations, by approximately six months' periods of time, showing in detail all operations, is set forth in Table V.

QUANTITY OBTAINED.

The run of a filter—that is, the number of days of operation and quantity in gallons obtained from the starting of a newly scraped bed to the time it is again necessary to clean it, is a most important item. The longer the run and the greater the quantity, the less the operating cost, as almost the only operating cost of a sand filter is the labor needed for cleaning. Table VI. shows the records at Albany, and that an average bed runs 26 days and furnishes 70,000,000 gallons per acre. The turbidity, or the amount and character of the suspended matter in the raw water, plays an important part in this matter, although we have found that where a filter has been started with the ordinary raw water and the sediment layer has formed, giving a friction head of about one foot, and then followed with a very turbid water, that the run of a filter has not been greatly lessened. It is therefore in the start of a filter that greatest care must be taken.

The operating results of our filters have been satisfactory. Several engineers have accounted for these results by stating that we have picked men. I wish to say that we do not have picked men. We pay only the ordinary rate of wages, viz.: $1.50 per day of eight hours, the same that is paid by contractors and other employers of labor. We only demand a reasonable day's work, but we insist upon getting it. Ward heelers and pot-house politicians who want to draw pay and do no work have learned that we have no use for them, and they no longer strive for a place upon our pay-roll. The result is that we have good, active men, who want both pay and work, and we give the pay and they give the work, and there is no nonsense on either side.

A part of our success is due to the attention which we have given to details of the work. We have endeavored to improve not only the work of the men and to simplify it, but to furnish them suitable tools. On the start, for scraping we used the ordinary straight-edged D-handled shovel. We learned that it lamed the backs of our men and they could not work to advantage. We abandoned those shovels for a long-handled shovel, which would allow the men to keep in a more erect position, and to overcome the slower handling of the new shovels we widened its blade to 12 ins. With these shovels our men scrape more than 100 sq. yds. an hour.

In the running plank used for wheeling out scraped material we found that to give a proper foundation and width we had to use two of the ordinary 10 to 12-in. wide plank, and then the service was not good. We had plank especially sawed 14 ins. in width, and one of these plank answers the purpose better than two of the others. They are placed as speedily as one of the other plank and the time is therefore reduced one-half.

The ordinary wheelbarrows used were not acceptable. On the grades that our men had to go the weight was shifted on the men's arms instead of being carried on the wheel, and we therefore re-adjusted all the wheels, giving a proper distribution of weight and saving the strength of our men.

In washing sand we had to wheel all the winter's accumulation from the storage bank up to the washer, and then it was fed into the hopper by shovel. To overcome this we devised a movable hopper, into which the men shovel direct. Water carries the sand to the washer and through it, and the men who formerly wheeled sand to the washer now wheel the sand away, and the output of the washer is increased 50%.

Our success has been in no small measure due to having a thoroughly energetic foreman, a man who has labored himself and who understands laborers, who plays no favorites, who changes the work of the men from point to point, so that they are not wearied out in the one employment, and thus keeps them in the best of condition.

TABLE VI.—Filter Bed Runs Between Scrapings at Albany.

		Filter No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	Totals and averages.
Longest.	Hours	1,016	893	900	974	844	833	766	911	.....
	Gallons (1 = 1,000)	76,267	73,585	76,982	73,352	69,807	70,491	64,264	74,033	.....
Shortest.	Hours	387	353	406	424	505	416	412	424	.....
	Gallons (1 = 1,000)	30,755	28,061	29,056	26,735	33,887	30,432	30,068	30,557	.....
	Runs	16	17	16	17	15	17	13	17	128
Total....	Hours	10,176	10,482	9,851	10,030	9,764	10,300	8,253	10,269	79,125
	Gallons (1 = 1,000)	789,349	813,777	768,781	784,154	775,994	837,824	656,741	814,962	6,271,582
	Days	26.5	25.7	25.7	24.6	27.1	25.3	26.5	25.2	25.8
Average.	Hours	636	617	616	590	651	606	635	604	618
	Gallons per bed	49,334	47,869	49,924	46,127	51,733	49,284	50,519	47,939	48,997
	1 = 1,000 per acre	70,477	68,384	71,320	65,896	73,904	70,407	72,170	68,484	69,984

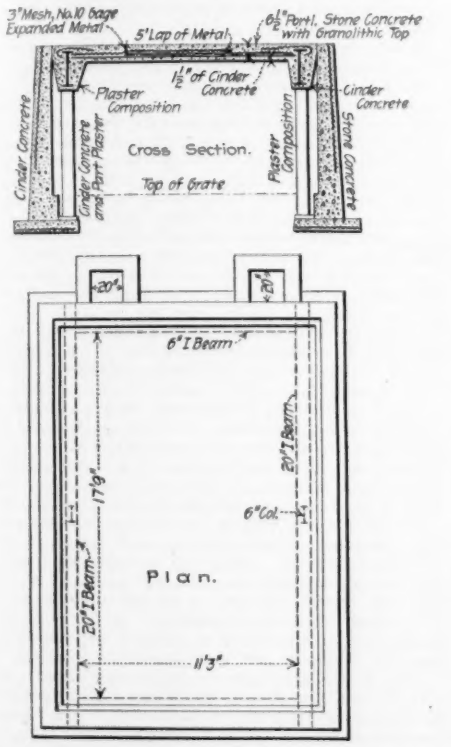
A FIRE TEST OF A LARGE SPAN CONCRETE AND EXPANDED METAL FLAT-ARCH FLOOR.

We illustrate in the accompanying cut the construction and method of testing of a concrete and expanded metal flat-arch floor having a clear span of 11 ft. 3 ins. × 17 ft. 9 ins. The test was made to demonstrate the capacity of large spans of this system of fireproof floor construction to resist the attack of fire and water when under load. The drawing shows the construction of the test-house fairly well. The floor was composed of 6½ ins. of Alpha Portland cement cinder-concrete, in which was embedded expanded metal with a 3-in. mesh, and of No. 10 gage. A span or bay in which a junction of the expanded metal sheets occurs was imitated in the construction. The concrete was composed of 1 part cement, 2 parts sand and 5 parts cinders, and the lap given to the expanded metal sheets was 5 ft. As shown by the cross-section, the beam protection on one side was plaster composition, and on the other side it was cinder-concrete. The minor details of construction are made sufficiently clear by the drawing.

Previous to the fire test the floor was loaded with 85,000 lbs. of pig-iron, or about 400 lbs. per sq. ft. This load produced a deflection of about 0.3-in. at the center of the floor.

The fire test was conducted as follows: A hot fire of wood drenched with kerosene was started

on the grate at 1.15 o'clock, and at 2.35 o'clock the temperature in the house had reached 1,950° F. The arrangements for measuring and recording the temperature consisted of electric pyrometers at about a dozen points in the walls, and there were also holes in the walls at four places through which pyrometers could be inserted. When the temperature had reached the figure given above, the observed deflection of the floor at the center was 2⅛ ins. The fire was maintained for about 2½ hours, when a stream from a fire hose was turned against the underside of the floor through a 1-in. nozzle. It was necessary to use 450 ft. of hose, so the nozzle pressure was only about 32 lbs., and the discharge 180 gallons per minute. The fire stream was maintained for eight minutes, and then the fire was rekindled and burned 30 minutes, after which the hose stream was again turned on, and the floor and building cooled. The effect of the fire and hose stream was to remove about ½-in. of the concrete from the underside of the floor, and from the beam protected with this material. The plaster composition beam protection did not withstand the attack so well. A record of the deflection taken after the fire and water test, showed it to be



Plan and Section of Concrete and Expanded Metal Warehouse Floor Subjected to Fire and Loading Test, at Boston, Mass., May 29, 1901.

3⅝ ins. It was also found that at the lines of junction between the floor and the walls, cracks had opened, perhaps, as wide as an inch and a half. In this connection it should be stated that the representatives of the expanded metal companies have informed us that the floor was improperly constructed, since no provision had been made for holding the beams, by tie-rods or otherwise, in position. The result was, since the beams were practically free to spread apart, that they twisted and careened under the action of the heat and water and opened cracks at the side walls. In view of these statements, it would appear that the results of the tests were of doubtful value as an indication of the behavior of the floor tested when subjected to the action of of fire and water. In conclusion, it may be noted that the test was made for the Eastern Expanded Metal Co., of Boston, Mass., as a demonstration to the engineers of the Boston & Albany R. R., who are considering the adoption of the type of floor tested for a warehouse to be erected near Boston. The expert in charge of the tests was Prof. C. L. Norton, of the Massachusetts Institute of Technology.

AN OFFICIAL REPORT ON THE IMPROVEMENT OF THE CHICAGO RIVER.

In our issue of May 2, 1900, we outlined the character of the investigations as to the improvement of the Chicago River, made by what has been called the "expert commission," a special body appointed by the Board of Trustees of the Sanitary District. This commission was rather summarily discharged before making its report to the board, as further noted in our issue of May 16. All the plans, estimates and other material were turned over to the board, and submitted to Mr. Isham Randolph, the Chief Engineer, for consideration. We are indebted to Mr. Randolph for a copy of his report on this matter to the engineering committee of the Sanitary District, and from this we take the following extracts. We omit the criticisms of the details of the estimates for pumping, etc., as these details were not given in our summary of the investigations. The board has recently decided to carry out dredging operations with a view of obtaining a channel depth of 26 ft. in the river.

The Board of Trustees on Jan. 9 passed the following resolution:

Resolved, That the Board of Trustees hereby appoint Orrin N. Carter, John P. Wilson, Lyman E. Cooley, Ambrose V. Powell and Louis P. Friestedt as a commission of experts to consider what improvements or changes should be made in the plans of the Sanitary District for the improvement of the Chicago River to allow the necessary flow of water with the least possible interference to navigation practicable, taking into account the present and future needs of the Sanitary District for furnishing the maximum flow of water under the Sanitary District Act, including the volume to be furnished by the 39th St. conduit, including the removal of center pier bridges, building bascule bridges, widening the river, building bypasses, establishment of dock lines and lowering the tunnels in the Chicago River. The commission hereby appointed is directed to also fully consider these points from a legal and financial standpoint and make comprehensive report on or before March 1, 1901, to the board, covering all of the above matters and presenting a complete plan for all of the improvements above mentioned.

This Board of Trustees respectfully invites the co-operation, as consulting associates on said committee, of the following officials and representatives: By the permission of the Secretary of War, the officer in charge of this river and harbor district; by the city of Chicago, the Superintendent of Public Works and the Corporation Counsel; by the State Board of Health and by the Health Department of the city of Chicago, one representative each; by the Sanitary District, the Chief Engineer, the General Counsel and the Chairman of the Finance Committee; by the Chicago Board of Trade, Chicago Real Estate Board and the River Improvement Association, one representative each.

Since the passage of the resolution on Jan. 9 the five gentlemen who constituted the expert board have been most diligent in prosecuting the work committed to them, and have accumulated a very large amount of data, which, as information, is exceedingly valuable. But the all-important question to the Board of Trustees of the Sanitary District was the adequacy of the plans already adopted by the board for the supply of water through the Chicago River to meet the requirements of the Sanitary District law, while at the same time meeting the commercial needs of the city of Chicago by improving the navigability of the river. The data submitted by the expert commission is accompanied by a letter of transmittal from the three engineers who prepared it, distinctly stating that they report no conclusions and make no recommendations favoring the adoption of any one of the schemes outlined. This being true, the discussion which I have prepared and submit herewith sets forth my own views on the merits of the projects themselves, and may be regarded as contemporaneous matter to be discussed upon its merits in any consideration which may now or hereafter be given to the projects figured upon by the experts.

The District was well advised of the possible future needs of the urban population skirting the Lake Basin on the north beyond its limits. It was in possession of surveys and other valuable data relating thereto, and it had data for determining the volume of flow that it must at some future period of its history be prepared to take into its channel through the Chicago River.

The questions therefore which were all-important to the board were these: (1) Will the plans of the District accommodate all future requirements so far as they relate to the objects and purposes for which the District was created without any infringement upon either travel or navigation; (2) will the improvements of the Chicago River on the scale of magnitude contemplated lend itself to that progressive development on the north which must come in the early or late future?

In my view, to answer these questions it was not necessary to do more than to determine what volume of flood and sewage must be brought through the north branch and past the main Chicago River into the south branch. What it may be necessary to do in caring for the sewage of the District south of and outside the Sanitary District was not an issue at this time, as the building of the channel south of Summit is an accomplished fact, and its capacity is established beyond the possibility of change for generations to come; hence there was no logical reason for determining what must be done for that outlying territory as a condition precedent to determining upon the adequacy of the plans for improving the Chicago River.

The experts, however, differed with me, and as a consequence of their broader view they give us a report covering, let us hope, every phase of the problems of the Sanitary District of Chicago within the State of Illinois and beyond its borders in Indiana. In treating the Chicago River the commission has laid down as a rule for its guidance in determining the cross-section a current of 1.193 miles per hour, after deducting an area of 1,000 sq. ft. for the presence of boats in the stream; and, further, it has assumed that this channel must carry 720,000 cu. ft. of water per minute. Both of these assumptions are without warrant. The permit of the Secretary of War, under which the current of the Chicago River was reversed, allows a current of 1¼ miles per hour in the stream without reference to boats, and the maximum volume of flow as set forth in the Sanitary District law is 600,000 cu. ft. per minute. This liberality is, therefore, entirely uncalled for. Navigation interests have no claims upon the Sanitary District for any conditions superior to those which existed in the Chicago River prior to the inauguration of work by the said District. What that condition was is a matter of such recent and general knowledge that it is almost unnecessary to rehearse it here, but as a part of the record let it be entered as follows: A channel depth of 17 ft., as dredged by the United States Government; a depth at dock lines of from 12 to 14 ft.; congested openings in drawbridges; narrow and crooked places in the channel, and a constant deposit of solid matter from sewers, etc. (which, according to Major Marshall, aggregated about 400,000 cu. yds. per annum), tending to reduce the available depth for flotation and make a constant tax upon the revenues of the government to maintain the depth fixed by act of Congress.

As a substitute for that condition, the Sanitary District has already created a channel depth of 20 ft. below the hydraulic grade line; it has undertaken to create a channel 200 ft. wide, with channel depth of 26 ft. and depth at docks of 16 ft.; it is building bascule bridges as substitutes for the obstructive center pier bridges; one of these is completed and four more are under construction; others will follow as fast as funds are available and the demands of trans-river traffic will permit. Under its plans a flow of 480,000 cu. ft. of water will be passed southward from Lake St. at a velocity of less than 1.25 miles per hour, and the remainder of the required volume, amounting to 120,000 cu. ft. per minute, will be brought in through the 39th St. conduit. It must be borne in mind that the vessel interests have suffered during the past season only on account of the unfinished condition of the work proposed by the Sanitary District. Vessels have stuck fast in the bridge openings or in narrow places in the stream where the work was incomplete. It is of record that with a flow of 350,000 cu. ft. per minute the velocity in the narrow stretch of channel west of 22d St. was only 1.93 miles (the cross-section in this place is only 217.3 ft. in width and 20 ft. in depth). With the same flow the velocity in the stretch east of Main St., which is now 200 ft. wide and 20 ft. deep, was only 1.08 mile. The width and capacity provided in the Sanitary District plans afford ample passageway for the flood waters brought down by the north branch of the Chicago River. The authorized scheme, therefore, meets all of the reasonable requirements of navigation, complies with the Sanitary District law and affords the fullest benefits to all of the interests which the District ought to guard, for the least outlay of money, the estimate being $9,024,000. Besides this, the seemingly inevitable inflow from the Calumet region will tend to reduce the volume to be supplied through the Chicago River, and thus still further minimize the velocity in said stream.

As an alternative to the plan of your adoption, there are various schemes suggested by the expert commission, which they index as Schemes No. I., II. and III. Of these the first is a scheme of river improvements which would make it a very roadstead for commodiousness; and let me say here that its magnitude is imposing and its boldness fascinating. That is just the thing I would like to see if it were practicable, but the cost is staggering. When we examine the map and see that the expenditure (modestly estimated at $22,862,879) means the wiping out of at least 80% of the business interests which now make the commerce on the south branch of the Chicago River and calls for a recasting of the city's subdivisions so as to get depth of property fronting on the new improvement sufficient for the uses to which water frontage is dedicated; and when we realize that all the money already expended and that the obligations entered into by the Sanitary District in improving the conditions of the Chicago River in keeping with the plans of the Sanitary District (amounting to $580,000) will have been wasted, and, for that reason, will have added that much more to the cost of the proposed scheme, our enthusiasm for it subsides, and we see that it is impracticable, first, on account of cost, and, second, because many generations will pass away before the territory can be subdued for this new use; for we all well know that the vested rights and

intrenched interests to be invaded will make common cause against this invasion, not to say obliteration of their multiform enterprises. The "Radical Improvement" under Scheme No. 1 is therefore entirely removed from the category of things possible of accomplishment.

The "Moderate Improvement," under Scheme No. 1, calls for a river 360 ft. wide southwest of 17th St., a subterranean channel from the river to the lake in the vicinity of 16th St. (costing $4,799,114) and a moderate improvement of the river from 17th St. to the lake. This moderate improvement, according to the showing of the experts, will not care for the flow of sewage and flood waters, which we know will come down the north branch, and which will, of course, find its way into the lake if it cannot go down the moderately improved south branch, unless controlling works, such as they suggest, are resorted to. The estimated cost of this moderate improvement is $12,701,755. In both proposed improvements under Scheme No. 1 there is an item of $1,616,900 for enlarging the main channel from Robey St. to Summit to a bottom width of 220 ft. The plans of the Sanitary District for this stretch are based upon 183.26 ft. bottom width, side slopes 2 to 1. This section, with a minimum depth of 22 ft., will flow 613,000 cu. ft. per minute at a velocity of 1.4 miles per hour. The cost of this excavation would be about $992,000.

We are in full sympathy with the navigation interest, and are prepared to go to the limit of our ability in its protection and improvement, but that ability is limited by the letter and the spirit of the law for the creation of sanitary districts within the State of Illinois. We are not willing to subordinate the prime objects of this channel to navigation, nor to use the resources of the taxpayers of this District in furtherance of harbor development or the exploitation of a ship canal, save as the same is a legitimate incident in the scheme of sanitation.

CALUMET REGION.—For this region we have, in connection with Scheme No. 1, two alternative suggestions: (1) The Sag Valley route, a canal project, estimated to cost $3,600,000, the canal to be supplied with water by pumps at Blue Island, delivering 60,000 cu. ft. per minute into the proposed channel. As a solution of the maintenance of the navigable features of the Illinois & Michigan Canal this is an admirable project. As a means of diverting sewage from Lake Michigan it is absolutely abortive. A review of the conditions to be met demonstrates this. The discharge of polluted waters from the Calumet River into Lake Michigan is not an evil constantly prevailing, but is a common menace and an intermittent evil. In dry seasons and calm weather the small discharge from the river into the lake can scarcely be said to make any current, and hence the organic discharge from sewers simply lies in the river channel and rots, awaiting freshets or lake changes to disturb its quiescence and carry its foulness out into the lake.

The pollution of the main Calumet River by sewers is limited to sewers entering at 103d St. and between that point and the lake. The main source of pollution is at Hammond, Ind., 11.37 miles from the lake, slaughter houses and glue works being located there. Into the branch which comes past Blue Island on the west a 5½-ft. sewer discharges at Wildwood, a 10½-ft. sewer at Wentworth Ave. and a 6½-ft. sewer at its confluence with Stony Creek. The cross-section of the main river from its mouth inland for a distance of two miles affords a width of 200 ft. and a depth of 20 ft., giving a cross-section of 4,000 sq. ft. The resulting velocity of flow for 60,000 cu. ft. per minute, if that entire volume were drawn in from the lake, which is not the case, would be only 15 ft. per minute or an inappreciable movement; hence organic matter from sewage would settle in the channel just as it does to-day. This flow would not affect the Hammond pollution in the least, and would affect the sewage discharged in the stream west of Riverdale only. The proposed pumping works would be located 15.6 miles from 95th St., or 16.8 miles from the lake. The results of the consummation of this plan, therefore, would leave the pollution where it is to-day, ready to be swept by wind-made currents or scouring floods into the lake, but navigation on the Illinois & Michigan Canal would be cared for.

(2) The alternative suggestion, or the "northern route," is estimated to cost $6,366,000. This project has but one advantage over the Sag Valley route, and apart from that is subject to all of the objections urged against that project. The one advantage is that the northern route lends itself to service in receiving the effluent of sewers on the south side of the city which may be made to discharge into it, and that by a sewer intercepting all of the South Chicago sewers and discharging into this canal via the northern route the discharge would be kept entirely out of the Calumet River. This project also serves the Illinois & Michigan Canal as effectively as the Sag Valley route.

It should not be forgotten that the Illinois & Michigan Canal has been a most offensive open sewer, and has been a blight upon real estate along its route; and the creation of its duplicate extending diagonally across the southern part of the city from 100th St. and the Calumet River to about 57th St. and the westerly limits is not a project which would find much favor in the eyes of the people whose property would be subjected to the detrimental effects of such a creation.

We who have lived in Chicago since the establishment of the Bridgeport pumps know what a poor makeshift that attempt at relief proved, when drawing its supply from the lake within less than six miles of the site of the pumps through a channel with scarcely half the cross-section of the Calumet River. Our experience has been that much of the organic matter discharged from sewers into the river simply festered in the channel until freshets carried its poisonous aggregations out into the lake and fouled our drinking water. It should be remembered, too, that in flood times these pumps had to be stopped because the channel of the canal was surcharged by local floods. The same condition would obtain in either of the Calumet projects under Scheme No. 1, which we have had under discussion.

Nothing has been done by this District which can hinder a wise treatment of the sanitary problems south of 87th St., and what the Sanitary District has already done is a tremendous contribution to the final provision for that region. This District once made a move in the direction of aid to that section, but was balked by the people who live within the territory to be benefited.

PUMPING STATIONS AND CONDUITS.—In the matter of cost of pumping stations completely equipped, I have arrived at the cost per horse-power by the best approximations possible without having actual plans upon which to base my figures. I do not differ very materially from the data submitted to the experts as given for the North Shore station and for the Calumet station, but we singularly find an irreconcilable difference in results when we compare with the Lawrence Ave. and the 39th St. pumping stations. When it comes to the cost of operation, we find the wildest discrepancy between the figures submitted to the experts and those which I believe to be conservative. I am surprised at the inconsistencies which develop in comparing the cost of service of $9,127 for the North Shore station, with the capacity to pump 60,000 cu. ft. per minute, and cost of service fixed at $20,984 for the Lawrence Ave. station, which is to have a pumping capacity of 37,000 cu. ft. per minute, or with the cost of service fixed at $51,879 for 39th St. station, with a pumping capacity of 128,880 cu. ft. per minute.

The experts have presented an empirical method of arriving at the cost of operating such plants. Now, Webster defines empirical as "used and applied without science." This formula is in unison with the last two words of Webster's definition, but we cannot believe that its use and application was ever known to any plant more inefficient than the Bridgeport pumping works, whose evil fame as the monumental example of how to do the least work for the most money has gone beyond the confines of Chicago.

They do not give proper weight to the fact that industrial organizations reduce coal bills by using slack costing from 90 cts. to $1.10 per ton and effect a saving of about 40% over coals costing $2.25 to $2.40 (the units of cost per ton used in figuring cost of operation in the tables submitted to the experts). With the best modern equipment in competent hands, there is no reason why a municipality should not attain results comparable in economy with those attained by any private corporation.

I fail to agree with the findings given in the data prepared for the experts for friction head and pumping head, either in the Lawrence Avenue conduit or the 39th St. conduit. Although I submitted my figures to the experts during the progress of their work and asked that errors, if found, be pointed out to me, I received no information tending to enlighten me beyond the statement that they used "n" (coefficient for roughness) in Kutter's formula as 0.018, while we use "n" as 0.015. I fail to recognize the propriety of this increased value of "n." There is no evidence which warrants me in discarding the findings of Kutter, Trautwine, Merriman, Fteley (who gives as the result of his own investigations "n" equal from .0142 to .0146); Benzenberg, who, by test on a 12-ft. brick conduit, found "n" equal .014 to 0.114; and Fitzgerald, who adopted .015 after a personal examination of the 39th St. conduit and left us his conclusions in his report as engineer of the Governor's special commission. He had associated with him as an expert in that work Mr. Frizell, and the natural inference is that they agreed in their conclusions.

Certain comparisons of the cost of pumping plants, together with capitalized cost of operation, with the cost of open channels, are made; and these I cannot accept, because I do not accept the figures from which they are deduced.

In discussing the volume of flow which it is proposed to pass through the 39th St. conduit, preferment is given the statement contained in a letter from the Commissioner of Public Works, in which he uses 128,680 cu. ft. as the volume to be provided, rather than 120,000 cu. ft. per minute, the volume reported by the Chief Engineer of the Sanitary District, notwithstanding the president sustains the chief engineer; this, too, in the face of the ordinances and agreements, which are made exhibits, relieving the city of all further responsibility or authority in the premises after it shall have provided the conduit and a pumping plant—to be erected and equipped in a manner acceptable to the District—capable of delivering a minimum of 40,000 cu. ft. per minute. This is simply piling up cost against an unfavored method of supplying [illegible] in contrast to other projects.

I note the cost of gravity channels from the [illegible]met discharging into the Sanitary District Canal on a [illegible]ute route, the "Calumet Summit" and the "Calum[illegible]g." On the first-named the cost ranges from $9,458,8[illegible] for a flow of 228,600 cu. ft. per minute up to $17,273,6[illegible] for a flow of 599,100 cu. ft. per minute. On the last-m[illegible]ned the cost ranges from $11,279,854 for a flow of 27[illegible] cu. ft. per minute up to $26,143,274 for a flow of 68[illegible] cu. ft. per minute. These estimates of cost bar the [illegible]ous consideration of either project at this time.

I do not feel that there is any pressing call [illegible] the adoption at this time of any solution of the C[illegible]met problem. The territory over which that problem [illegible]ads is not within the jurisdiction of the Sanitary Distri[illegible] and its annexation does not appear to be imminent. Nevertheless, the discussions of things that may be done to aid that territory and form a part of the general scheme, as presented to the experts, are both interesting and instructive, and when the time is ripe for action they will serve a purpose as being so much available information bearing upon the solution of these grave questions. The proposed diversion of flood waters of the Little Calumet into Lake Michigan at a point in Porter county, two miles east of the west line of said county, is a suggestion worthy of the best effort of the property owners of the Calumet region, altogether apart from its merit as a factor in the eventual work of flood disposal as an element in the execution of a "comprehensive plan" for sanitation. Its execution would be comparatively easy if the question of governmental jurisdiction did not intervene to hinder it.

When these questions come up for final determination, I may have no voice or influence in that determination, and therefore I avail myself of this opportunity to protest against any solution which will bring into the Desplaines and Illinois valleys the flood waters of the shed tributary to the Calumet region or any portion of them. The provision already designed for maximum discharge of flood and main channel waters through Joliet is, I believe, fully adequate to the requirements that must be met. That determination is based upon a flood discharge from the Desplaines watershed north of Joliet of 800,000 cu. ft. per minute; flood waters from the area tributary to the Illinois & Michigan Canal north of Joliet 100,000 cu. ft. per minute, and a normal discharge of 600,000 cu. ft. from the main channel of the Sanitary District.

I know of nothing authentic which would tend to invalidate the conclusions arrived at prior to the determination of the plans adopted by the Sanitary District for its work through Joliet. The introduction of flood waters in excess of these determinations from territory not naturally tributary to the flood volume of the Desplaines and Illinois valleys would create an element of liability to the inhabitants of the territory whose property would be placed under servitude to flood conditions which ought never to be added to the burden of the Sanitary District.

The letter of the experts transmitting their work distinctly states that they report no conclusions and make no recommendations. I desire as distinctly to report my conclusions and make my recommendations as follows: My belief is that the plans of the Sanitary District for the Chicago River are adequate for the future development of projects for relief of territory adjacent to and north of Chicago; that they afford provision for the volume of flow demanded by the Sanitary District law, and that while meeting these conditions they contribute to the commercial interests of Chicago by providing a stream deep enough and wide enough to meet the needs of navigation, and that, too, with a current which comes within the reasonable limitations made by the Secretary of War, in whom is vested the power to regulate any artificial flow which may be created in navigable waters of the United States. I feel, therefore, that you are justified in inviting all those who have the best interests of Chicago at heart to join with you in an earnest effort to bring the plans of the Sanitary District to early completion. The cost of completing the 200-ft. river project, with a channel depth of 26 ft., as figured by me, will be $9,024,000, and as submitted by the experts $8,690,900, or nearly 3.69% less than our own estimates. This is certainly a remarkably close result, when the intricacies of the work are considered.

DES MOINES RIVER VIADUCT; CHICAGO & NORTHWESTERN RY.

In our issue of June 6, we described briefly the general character of the large railway viaduct recently completed by the Chicago & Northwestern Ry., on its new cut-off line now being built through Boone, Iowa. Since then we have received a photograph of this interesting structure, and reproduce it herewith. We also find a description of the construction and erection of this viaduct contributed by Mr. W. C. Armstrong, of Boone, Ia., to the June, 1901, issue of "The Iowa Engineer," published by the Engineering Department

of the Iowa State College, of Ames, Ia. From this paper we take the following details, not given in our previous article:

The common practice in viaduct construction is to make the tower span about half the length of the open span—30 and 60 ft. respectively being very generally employed. One difficulty which designers have always met where the tower span is made half the length of the open span is in the question of depth of girder. The longer the span the deeper it must be made for economy. Therefore, it is necessary to make a 60-ft. span much deeper than one 30 ft. in length. This usually involves objectionable details in connecting the two spans to the same column. It is, however, possible to vary the depth of a girder a half foot or even one foot from the theoretical economic depth with a very slight sacrifice of material; and by reason of this fact, it was sought to overcome this objectionable feature by adopting the 45 and 75 ft. lengths. The girders were made uniformly 7 ft. deep, which is a medium between the economic depths of each.

Another reason for adopting the 45-ft. tower span was to give a sufficient spread at the base, so the effect of traction resulting from the sudden stopping of a train on the structure would produce no uplift at the foot of the columns. The columns batter laterally at the rate of 2 ins. per foot, which makes the distance apart, in a line at right angles to the axis of the bridge, 70 ft. for the highest towers. This is sufficient to prevent any uplift from the effect of wind pressure on the sides.

The tower columns are made of three I-beams placed together in the form of the letter H. Two 20-in. beams form the sides, and one 15-in. beam makes the connection between the sides. The longitudinal and sway braces are all stiff members made of two 12-in. channels laced together. The system of bracing is that of the Warren girder type, i. e., all braces are diagonal and intersect each other at the center. There are no horizontal struts, except at the bottom of the tower, where all four columns are connected by 15-in. channel struts.

The span across the river channel is 300 ft. long, 60 ft. deep and divided into five subdivided panels. It is carried on A-shaped towers at the ends, which are supported by steel cylinder piers 10 ft. in diameter. The truss span presents no unusual features except in the matter of providing for expansion and contraction. This is done by making the end posts at one end of a rocker bent, and allowing the pins at the foot of these posts to slide in slotted pin holes of the bottom chord. The floor beams rest upon the top chord, and the stringers are placed on top of the floor beams. This was done in order to reduce the height of the towers supporting the span to a minimum.

Work in preparation for actual construction was begun in the spring of 1899. The charater of material encountered was that usually found in bituminous coal regions—clay, shales of all colors, sandstone, fire-clay and coal. At the ends of the structure, the stratified material was overlaid to so great a depth with hard blue and yellow clay, that it was not deemed advisable to go such great depths for foundations. So for the abutments and piers supporting the low towers, pits were dug in the clay to a depth of 12 or 14 ft. and beds of concrete from 4 to 6 ft. in depth were deposited as a foundation for the stone work. The area of the concrete base was made such that the pressure per square foot would not exceed two tons. Farther down the hill where stratified material was nearer the surface, the excavations were carried down into the stratified material and foundations made usually on black shale, and never on fire-clay or coal. The foundations were prepared in the same way as for clay—three tons pressure per square foot being allowed. Near the river, where a large mass of sand overlaid the stratified material, and where the surface of erosion was approximately level, piles were driven, cut off at the water surface, and concrete deposited around and on top of them for the masonry foundation. Fifteen tons pressure per pile was allowed.

The abutments were rectangular blocks of masonry, 50 ft. × 30 ft. at the base, with reinforcing buttresses in front. The earth filling was carried round in front of them, so that when finished the only portion left in view was that from the coping of the bridge seat up. The piers supporting viaduct towers are 5 ft. square on top. They are built with a batter of 2 ins. per foot, and the bases vary from 12 to 20 ft. square, according to their height or the pressure they exert on the foundation material. The masonry was all of Mankato limestone laid in Portland cement mortar. The pedestal blocks supporting the steel columns on top of the piers are of Albeman's sandstone.

The steel cylinder piers supporting the 300-ft. span are eight in number—four under each end of the span. They were sunk by the pneumatic process. A compressor plant consisting of two 60-HP. boilers, two Ingersoll-Sergeant air compressors, the necessary pumps and an electric dynamo for lighting purposes, was installed on the shore as convenient as possible to the work. A temporary bridge about 25 ft. above the water had been erected across the river, underneath the floor of which the air pipes and electric wires from the power plant were carried to the piers on the opposite side of the river, and over which material for the same was transported.

The piers are 10 ft. in diameter, and consist of a steel sheel ⅝-in. thick, made in sections 5 ft. in height, which were added and riveted as the piers were sunk. The bottom section was 8 ft. in height, with a steel diaphragm framed in 1 ft. from the upper edge, which formed the roof of the working chamber below—making the working chamber 7 ft. high. Fig. 2 shows one of these working chambers before it was placed in position. Through the center of the diaphragm is a hole 3 ft. in diameter, where the air shaft, which was a steel tube of the same diameter, was connected. At the top of the air shaft was connected a Moran air lock, through which material excavated from below was hoisted, and through which the men passed from the open air to the working chamber below and out again. The Moran lock is especially adapted to pneumatic work, where only one air shaft can be used, as it is a double lock; that is, one compartment for passing out material and one for the men. In large caissons two air shafts are usually used with an air lock on each.

The method of work was as follows: The working chamber was placed in position, a section of the air shaft was then bolted in place with the air lock at the top. A section or two of the outer steel shell was riveted on, and the air pipes connected. Concrete was then filled in between the outer shell and the air shaft, and on top of the roof of the working chamber, sufficient to give the proper weight for sinking. The air pressure was then turned on, and workmen entered the working chamber through the air lock, dug up the material from beneath and shoveled it into buckets, which were hoisted out through the other compartment of the air lock. Usually for a short distance the whole mass would follow down as the material was excavated; but as the working was carried to greater depths, the friction of the earth on the sides was so great as to hold it up till a considerable amount was excavated, when by a sudden release of air pressure the pier would settle till the cutting edge of the working chamber rested on the bottom again.

When one pier had been sunk till the top of the concrete filling was about to the water surface, the air lock would be removed and placed on another pier, while additional sections of the outer shell and air shaft were being put on, and more concrete put in place—it being necessary at all times to keep the air lock, outer shell and top of concrete above the water.

The piers were all sunk to a stratum of sandstone which lay from 42 to 46 ft. below the surface. A maximum air pressure of 23 lbs. per sq. in. in addition to the normal pressure was used. A rate of progress as high as 16 ft. per day was made through the sand that lay near the surface, but an average of about 2 ft. per day was all that could be made through the hard shale and other stratified material encountered at greater depth. The work was begun on Feb. 7, 1900, and was all completed, including the sinking to position, riveting up of steel shells, filling of the working chamber, air shaft and all spaces whatever with concrete, and setting the anchor bolts and coping stone to receive the metal superstructure of the bridge, on June 6 of the same year.

The appliances for the erection of the steel work consisted of four derricks for unloading the material from cars as it arrived—two at each end of the bridge; two travelers for lifting and lowering the steel into position; two gasoline air compressors for running the pneumatic riveting machines, and numerous tools, push cars, etc.

The travelers are simply traveling derricks, which were moved along as the work progressed. There was one on either side of the river, as the work of erection was carried on from each end, and the two travelers met at the west end of the 300-ft. span. The traveler consisted of a steel framed bent, about 50 ft. high, made of three posts braced together, mounted on a platform which carried a hoisting engine, and which formed a place for the engineer, signalman and men operating the lines to work; and which also formed a place for the storage of coal, water and the hundreds of feet of rope used in handling the steel. At the bottom of this bent were attached two booms—one called the 90-ft. boom, the other the trolley boom. The 90-ft. boom was made of two 9-in. channels laced together, and stiffened against buckling vertically and sidewise by longitudinal truss rods. It was made to swing from a horizontal position through a vertical arc of 75°; and also had a horizontal swing of about the same amount. It was raised and lowered by means of blocks and tackle connecting the end of the boom with the top of the mast, and operated by the hoisting engine. The side movement was controlled by hand lines attached at the end of the boom and operated by men on the ground. The trolley boom was 51 ft. long, and always remained in a horizontal position, although it had a lateral swing of about 30°. It was made of two 18-in. I-beams, the upper flanges of which formed a track upon which were run two carriages or trolleys. Its lateral movement was controlled in the same manner as the 90-ft. boom, and it was supported in the horizontal position by means of rods extending from the end and two intermediate points to the top of the mast. From the top of the mast, back stays were run to the rear end of the platform, where they were connected with heavy anchor rods, which were securely clamped to the girder underneath to prevent the entire traveler tipping forward when a heavy load was being lifted. The 90-ft. boom and trolley boom were designed to carry 10 and 16 tons respectively at their extreme ends. The entire traveler was carried on four pairs of trucks, which ran on standard gage tracks 13 ft. c. to c., and was elevated on these tracks so that the platform stood about 9 ft. above the rail. This provided a passageway underneath and between the two tracks for bringing material forward where it could be reached with lines from the trolleys. The trolley boom was used for lowering and setting the girders in place and also for lowering material for the towers from the deck of the structure to the ground, whence it was picked up with the 90-ft. boom and raised to its place in the tower.

DES MOINES RIVER VIADUCT; CHICAGO & NORTHWESTERN RY.
E. C. Carter, M. Am. Soc. C. E., Chief Engineer; American Bridge Co., Builders.

No falsework was used in raising the viaduct, but the 300-ft. span was built on a very heavy falsework made of 8 × 16 Oregon fir timber.

The structure is finished with a very substantial floor, consisting of 8-in. square yellow pine ties, 12 ft. long and spaced 1 ft. c. to c. To their ends are bolted yellow pine guard rails 10 × 12 ins., and on either side of each rail is spiked a 4 × 10-in. plank longitudinally. Between the rail and the inner plank is spiked a 6 × 4½-in. angle, which will serve as a protection to the ties in case a derailed truck crosses the bridge.

The erection work was commenced in November, 1900, and was finished and the first train passed over May 19, 1901.

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The demand for assistance from the Government in the construction of irrigation works in the arid lands of the West, which was urged with great force during both sessions of the last Congress, is pretty sure to be brought forward with still stronger insistence when the next Congress assembles. As most of our readers will recall, it was the speech of a Montana senator which killed the River and Harbor bill at the last session; and it is not at all likely that a similar thing may happen again, if the demands of the far Western delegations are not met.

Press dispatches report a recent conference of Western Congressmen and Senators at Cheyenne, at which a bill was drafted for presentation to the next Congress. The gist of the proposed bill is given as follows in the telegraphic reports:

> That all money received from the sale or disposal of public lands in Arizona, California, Colorado, Idaho, Utah, Montana, Wyoming, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota and Washington, beginning with the fiscal year ending June 30, 1902, shall be reserved for the benefit of the state or territory in which said lands are sold, to be kept as a special fund, known as the "Arid Land Reclamation Fund," under the direction of the Secretary of the Interior. Each state shall maintain an engineer's office, who shall plan and make the estimates for the reservoirs. The plans shall be submitted to the Secretary of the Interior, who may approve or reject them. If approved, the Secretary shall set aside money for their construction, and such lands are to be exempt from entry. The state may sell the completed works to actual users of water.

It will be seen that the plan aims to meet the objection of those who have claimed that the Government could not undertake irrigation works without starting a huge drain on the national treasury. As stated, only money actully received from land sales can be used for reservoir construction. On the other hand, it is not clear just where the responsibility for the construction and maintenance of irrigation works would lie. The division of responsibility between the State and the Federal authorities would be pretty sure to lead to friction, delay and expense, if not to corruption and bad work. No one who has given any study to matters of irrigation can doubt that something in the way of legislation, State or national, or both, is urgently needed to make irrigation work the success it ought to be. But the public, at least in the East, is in the dark as to what legislation is really required. If the arid State representatives will present in the next Congress a thorough and well-digested scheme for the fostering of irrigation enterprise, it will have very fair chances of success. Such a plan as that quoted above, however, leaves too many loose ends for litigation to settle; and litigation has been the constant curse of irrigation enterprise in this country.

Last week's convention of the American Water-Works Association, to the proceedings of which we devote much space this week, was a notable improvement on recent previous meetings. In the first place, most of the papers read were printed and circulated in advance. Next, the entertainments so liberally provided were arranged so as to interfere much less than usual with the reading and discussion of papers, thus leaving more time for the latter. Another cause for an unusually successful meeting, was that most of the closely related subjects were grouped together, thus adding to the attractiveness of the program and facilitating discussion. Frankness compels us to say that all the foregoing points are such as should mark any meeting of a technical society of national scope; but unfortunately some or all of the features named have been lacking at earlier meetings.

Passing by mere details of arrangement it is a pleasure to note that the papers were particularly good. Two subjects were dominant, but they were quite harmonious. These were water purification and waste prevention. We have reprinted as separate articles elsewhere in this issue, a large part of the papers on the operations of the slow sand filtration plant at Albany, and the mechanical filter plant at Elmira, N. Y. It is a pity that the latter does not comprise detailed analysis of the labor involved and the cost of operating the mechanical filters; but no such figures have yet appeared for any mechanical filters.

Besides the papers on filtration we have detached from our report of the convention to print separately a group of three notable papers bearing on various phases of water consumption and the use of meters. In the discussion of these papers some of the speakers suggested that the expense of the plumber's work necessary to prevent the various leaks so largely responsible for high rates of water consumption and waste more than equals the cost of the water saved, thus resulting in a losing game for the consumer. It should be distinctly understood that if higher grade fixtures were installed at the outset, as suggested in Mr. Rosamond's paper, there would be no occasion to employ the plumber so often. The interest on the difference in first cost between good and poor faucets and water closet flushing devices would be a very small item, compared with either plumbers' bills or the cost of water wasted through defective fixtures.

Finally, we wish to give emphasis to the resolutions introduced by the special committee on electrolysis and unanimously adopted by the association. To that end, we reprint them here, instead of in our report of the meeting. Omitting the preamble the resolutions are as follows:

> * * * street railways have no right to so operate their cars as to cause injury and destruction to water pipes, and
>
> That street railways now operating under the single trolley system ought to be required to remove their return current from the ground, and that if they continue to operate by current transmitted from the power station to motors on the cars, they should be required to provide a complete metallic circuit of sufficient capacity to convey all the current, and in a manner to absolutely insulate it from the rails and from the earth.

This is clear cut, dignified and, at least in the end sought, eminently just. We have maintained, heretofore, that the water and gas interests should content themselves with stoutly insisting that the current be kept off their mains, leaving the methods entirely to the street railway companies. The last part of this resolution may appear to some to dictate the method to be employed, but it is only fair to believe that its intent is only to make it plain understood that the only way to keep all current off the water and gas mains is to provide a return circuit entirely independent of both rail and earth. The issue is squarely put in the resolution, and it is being quite as squarely maintained before the courts in a number of cases now awaiting decision. The interests at stake on both sides are large, but every effective step to stop the evil affords the trolley companies at least some compensation in reduced coal bills, while every delay on their part is fraught with more or less danger to life and property, through the rapid deterioration and resulting failure of gas and water mains.

In the current discussion respecting the comparative merits of English and American locomotives, which has raised so much commotion on the other side of the water, and echoes of which have been heard on this side, it is notable that the chief indictment brought against the American locomotive is its excessive fuel consumption compared with the English built machine. The facts regarding this are admirably set forth by our London contemporary "Engineering," in an article in which it warns English manufacturers that to attempt to meet American competition by decrying American goods and charging corruption against those who buy them, is a most absurd course. We quote as follows:

> In regard to the detail of fuel economy, we should not be at all surprised to find that British locomotives have a superiority. It is a question, however, whether we in this country have not made fuel economy a feature to which too much has been sacrificed. It is a detail of expenditure, doubtless an important one, but it is possible to overestimate its value. The American railway manager takes the view that a few dollars extra spent on coal is a profitable outlay, if it enables an engine to do more work, better time to be kept, and other economies to be secured, in regard to capital expenditure, wages, etc.

It is probably true that the American locomotive, on the average, burns considerably more coal than its European competitor. Comparative tests, where they have been made, have generally shown this to be the case. The main reason for this, we believe to be exactly that which our contemporary states—the desire to gain in capacity. On American railways, if a freight locomotive could be made to haul three or four more cars by contracting the exhaust nozzle, and thus increasing the rate of combustion, the change has been made, and the money saved has paid several times over for the extra fuel consumed.

It is probable that this fact more than any other explains the difference in fuel consumption between American and foreign locomotives; but it is a difference which is not essential and which may not always work as advantageously in other countries as it has in the United States. In many foreign countries coal is very expensive, and the volume of traffic is not such that large hauling capacity is an essential feature of a successful locomotive as in the United States. For service in such countries we know of no reason why American locomotives should not be built to give a fuel economy as high as any recorded for foreign locomotives. If they do not, then we must look to either faulty design or faulty management for an explanation.

We note in this connection that the London "Railway News" of June 8 quotes Mr. S. W. Johnson, Locomotive Superintendent of the Midland Ry., as follows:

> We put on our line 30 Baldwin locomotives and 10 from the Schenectady Locomotive Works. The orders were given in February, 1899, and the engines were delivered in the second half of the same year. Now, these engines wre not at all English engines, as it were, built in America. We laid it down that they were to be of the same power as the Midland standard goods engine, and there were a few small details to which the manufacturers had to conform; but, generally speaking, the Americans had a free hand, and the engines were for the most part of their own design and pattern, and made in their own way. When they arrived we put them on to our mineral trains running between Toton sidings, Wellingboro' and London, and set them to do the same work as our own standard engines were doing.
>
> In January of last year we commenced a six months' comparative test, terminating at the end of June, between these Americans and our standard Midland goods engines, built by Messrs. Neilson, Reid & Co., of Glasgow, and Messrs. Kitson & Co., of Leeds. The two types were set to draw similar mineral trains under the same conditions,

and a careful account was kept of the total mileage covered by each, the total coal consumed and the charges for repairs which belonged to each engine. The result was conclusive, and is briefly as follows:

Extra Working Cost of American Engine Over English Engine.

Fuel	20-25%
Oil	50%
Repairs	60%

It must be said for the foreign engines that they worked their trains satisfactorily, but their inferiority on the three points named is, on the above showing, incontestible.

We said above that the extra fuel consumption might be due either to the builder or the user. If the locomotives were given such exhaust nozzles as would commonly be employed on an American railway, that alone would be sufficient to account for the increased fuel consumption compared with the English built machines. On the other hand, the designer may have done work beyond criticism; and after placing the locomotives at work, the draft arrangements in the front end may have been altered by runners or shopmen without experience in the handling of American appliances. A little monkeying of this sort with the deflector plate, etc., might again be sufficient to account for the greater fuel consumption which the engines showed.

That the above guess at the reasons for the alleged excessive fuel consumption of American locomotives is pretty close to the mark is indicated by the following extract from a report of the Locomotive Superintendent of the Bengal Central Ry., published in the New York "Journal of Commerce:"

> The five American engines were received and started to work in July and August, 1899. At the commencement of their career the engines did not steam at all freely. This was remedied by taking all the deflecting plates out of the smokebox, and by reducing the number of fire bars from 24 bars to 22, which removed the defect. The next evil was the high consumption of fuel, almost 70 lbs. per mile. The exhaust pipe was taken out and another one substituted with a single exhaust and widened out to 4¼ ins. at the top, and also lengthened 10 ins. higher up toward the bottom of the chimney. By the introduction of this pipe and blast cap the consumption was brought down considerably, and after fixing an oil lubricator on the cylinders for the pistons the consumption of coal is now as low as the "H" class engines. Taking the last six months of 1900 the Americans burned 40.625 lbs. per mile, and the "H" class 44.416; the larger amount was burned by the "H" class having run more goods trains than the Americans did.

We bring forward this matter thus prominently because there appears to be a general idea that the American locomotive is inherently different from the English machine, and that if it can be proved to have sinned in the matter of fuel consumption, its doom in the export trade of the world is sealed. To any one familiar with locomotive design such ideas are at once seen to be absurd. The fact is that American and English locomotives are in their essential and important features practically identical. We know of no reason why a specification for a locomotive to show a given fuel economy cannot be filled as well by the Baldwin Works or by the American Locomotive Co. as by any English locomotive builder.

FEED WATER HEATING FOR LOCOMOTIVES.

Wanted: a steam pump. One which will feed hot water to locomotive boilers, and will be as reliable, efficient and practically convenient as an injector. If any manufacturer or inventor is in position to furnish such a piece of machinery, the railway motive power officers want to find him.

In a report to the Master Mechanics' Association on "Methods of Economizing Fuel Consumption in Locomotives" (reprinted on another page of this issue), an extended description is given of a scheme for heating the feed water in the tender tank (or rather in a compartment partitioned off from the main tank), by the exhaust steam from the air brake pump, and a portion of that from the main cylinders. There is nothing doubtful or experimental about this. It is perfectly practicable to do it, and in fact it has frequently been tried. The rock on which all the schemes for locomotive feed-water heating have split is the difficulty in feeding hot water with injectors. Of course, there are plenty of injectors which are advertised to feed hot water; but what the makers really mean by this is water with the chill taken off. When it comes to feeding water of 180° or hotter to a boiler, the injector is, from the very manner in which it operates, entirely out of the race. In any injector, the steam which it uses must be condensed by the water which it forces into the boiler, and this condensation must take place in the extremely short period of time which it takes for the mingled stream of steam and water to pass through the combining tube. With hot water, the time required for condensation is too long, and the injector will not work. Some of our readers may recall an American locomotive for an Indian railway, which we illustrated a few weeks ago (May 23), equipped with an independent pump for boiler feeding, the reason for its use being that water in the tender tank in the climate of India often becomes too hot for injectors to handle. This is a good illustration of the limitations to locomotive feed-water heating so long as injectors are used.

And now let us see what difficulties must be overcome by the designer of a successful pump to feed hot water to locomotive boilers. Such a pump must be an independent machine, of course. The railways will not go back to the old plan of driving pumps from the cross-head which preceded the days of the injector. There is no room for pumps of that sort on modern heavy locomotives anyway; and even if there were, the nuisance of breakdowns and of a machine which must run always at the speed of the locomotive, and which cannot deliver water at all when the locomotive is standing and water is needed to keep down the steam pressure and prevent blowing off, would be sufficient to condemn the plan.

The boiler feed pump must be steam-driven, like the air brake pump; but it must be economical in its use of steam or it may neutralize a good part of the saving due to the feed-water heating. The injector, it must be remembered, feeds the boiler with no loss of heat. All the steam it uses goes back into the boiler. But with the feed pump, all the steam it uses is so much lost from the boiler, and to be subtracted from the heat-saving due to feed-water heating. An arithmetical computation may make this point clear to those not familiar with the subject.

Suppose we have a feed pump delivering water to a locomotive boiler carrying 200 lbs. steam pressure. Suppose the pump uses to do its work, say 70 lbs. of steam per horse-power hour of water actually delivered—a duty quite as high as could reasonably be expected from any such small size steam pump of simple construction. The computation is as follows:

1 HP.-hour = 33,000 × 60 = 1,980,000 ft.-lbs.

200 lbs. pressure × 2.31 = 462 ft. head.

1,980,000 ÷ 462 = 4,286 lbs. water delivered per HP.-hour.

Heat units above 50° F. in 1 lb. of steam at 200 lbs. pressure = 1,182; 1,182 × 70 = 82,740; 82,740 ÷ 4,286 = 19°.

In considering the substitution of a feed-water heater and pump for feeding by injectors, therefore, about 19° of the increase in heat of the feed water will be offset by the steam consumption of the feed pump, and should be deducted in computing the economy to be expected by feed-water heating.* This leaves, nevertheless, a large margin for economy. The average temperature of the water in a locomotive tender tank, taking both summer and winter, is probably not far from 50°. It should be quite possible to raise this to 180°, or an increase of 130°, and deducting, say, 20°, on account of the steam used by the feed pump, leaves still 110° of net saving. As stated above, with 200 lbs. boiler pressure, 1,182 heat units are required to make steam at 200 lbs. pressure from feed water at 50°. Hence every increase of 11.82° (or say 12°) in the temperature of the feed water means a saving of 1% in fuel consumption. Heating the feed water 110°, therefore, would result in about 9% saving in fuel consumption. What is still more important, probably, it would increase the steam-making capacity of the boiler by an equal amount, since the heat required to be imparted to a pound of water by the boiler-heating surface to transform it to steam at boiler pressure is reduced by 9%.

Moreover, the gains through feed-water heating do not end here. The reduced strains on the boiler through the delivery of the feed water at a temperature near the boiling point, are thought by many engineers to be an important matter. There are some possibilities, too, in the direction of partial purification of the water from scale-forming constituents by heating it in the tender tank. Whatever deposit can be induced there means just so much less to be laboriously washed out and dug out of the boiler.

There is, then, quite enough gain in feed-water heating for locomotives to be worth the attention of railway managers; and as we said at the outset, the practicability of the scheme hinges upon the appearance of a satisfactory pump.

We have shown why the pump must be, in the first place, reasonably economical in the use of steam, but this is only one of the specifications which it must fulfil. Most important of all is its reliability. It must be so simple in construction and so securely put together that the engineer can be assured of its working so long as its steam valve is open. Any weakness at this point means danger. With a locomotive working at its full power the consumption of water is so rapid that if the supply of feed water be interrupted, the water level in the boiler may fall at the rate of an inch a minute. Thus a stoppage of the feed pump may lay the crown-sheet bare in three or four minutes. Even apart from the question of danger, the matter of reliability is all-important. A pump whose breakdown should stall an important train on the road would be blacklisted. Railway officers are proverbially slow to make changes. It took a long time for the injector to displace the old cross-head pumps, notwithstanding its manifest disadvantages. If a pump is again to displace the injector, it must equal or even exceed the injector in reliability. A railway manager pays no attention to failures in the standard apparatus which he has always used. They are the ordinary and inevitable accidents, bound to occur once in so often. The same percentage of accidents, with a new device, however, is sure to condemn it forthwith.

The location of the pump is pretty positively fixed by the fact that it must handle hot water. It must be placed, therefore, below the level of the tender tank so that the water will flow to it by gravity, and it will probably be found that the handling of hot water will impose some limitations as to the pump's plunger speed. Of course, a location beneath the footplate makes the pump inconvenient to reach for inspection or repair; nevertheless, there it must go, for its successful handling of hot water will pretty certainly depend upon its being placed close to the tender to make the most of the head that can be obtained in the suction pipe. It will be seen, also, that its inaccessible location furnishes an additional reason why the pump must be absolutely reliable, and must operate with the minimum of attention.

The capacity of the pump must be such that it can deliver water as rapidly as the maximum rate of evaporation from the boiler it is to supply, perhaps 30,000 lbs. of water per hour for a medium-sized locomotive. It must attain this capacity without excessive speed, for the reason noted above; must not exceed reasonable limits of weight, and must be so compact that space can be found for it without interfering with other necessary parts. Besides operating at its full capacity, it must be readily graduated to operate at any smaller capacity or lower speed merely by throttling the steam supply.

There are other minor points which the designer would have to consider; but this will do for the main outlines of a specification. When any inventor or manufacturer can comply with the above requirements, he can, we believe, find a large market for his machine.

It will be said, we presume, that the task set is an impossible one, and that such stringent requirements can never be met. It appears to us, however, that while the task is difficult, there are no greater difficulties than have been successfully overcome in the solution of other mechanical problems.

Such a successful solution would make possible

*We have referred to the steam used by the boiler feed pump as a dead loss. Of course, however, it may be also used for feed-water heating like the exhaust from the air brake pump. We can hardly credit it with its full heat value, however, since the air brake exhaust and what can readily be spared from the cylinder exhaust without interfering with the draft would doubtless be quite sufficient to heat the feed water to the limit of temperature.

the largest measure of advancement in locomotive engineering that has been recorded for many years. So long as a successful hot water feed pump is lacking, however, so long is feed-water heating for locomotives sure to fail of practical success.

LETTERS TO THE EDITOR.

The Eccentricity of Object Glasses.

Sir: In the issue of Engineering News of June 13, we note an interesting letter by Prof. Cain, of the University of North Carolina, on the "Eccentricities of Object Glasses in Telescopes," in which it is pointed out that in a very large percentage of the object glasses of transits "it is impossible to so adjust the instrument that the cross-section of the cross wires will cut points in a line which is straight, both horizontally and vertically."

It has long been the custom with ordinary makers of transits to throw this error into the horizontal line. Out of the many transits by the best makers in this country, which have come into our hands for repairs, we have found few in which this error did not exist. Some years ago, having arranged to produce our own object glasses for our transits, we found that by the use of special apparatus for the purpose, we were able to secure object glasses free of eccentricity; and in tests made on a transit recently furnished by us to Mr. Helweg, of the U. S. Navy Yard at Philadelphia, it was found that results were obtained practically identical with the interesting results submitted by Prof. Cain. This transit is being used daily in establishing grades by the transit method, or as it is usually called, "plunging the grade."

We are glad that Prof. Cain has brought out this point in transits, as it is a matter of considerable interest and importance to engineers. Yours very truly,

Queen & Co., Inc.,
Per J. G. Gray, Pres.

Philadelphia, Pa., June 19, 1901.

Concerning the Rusting of Iron or Steel Imbedded in Concrete and Immersed in Water.

Sir: I read with interest the editorial remarks in your issue of Feb. 7, last, on the use of Monier pipes as a pile covering, and in lieu of cast-iron cylinders (my notes on which you published in the same issue).

The point you raise as to the possibility of the rusting of the steel enclosed in the cement composition forming the pipes is very fair comment. Before making use of the system we made a number of experiments (which I did not detail in the published notes), with a view to clearing up this point, but the particular application of Monier under notice is too recent to admit of any record extending over a long period.

Since reading your article I have had an examination made of a number of piles protected in this manner about three years ago, and find that the outer surface of the pipes are so closely covered with small barnacles, etc., as to be, as it were, glazed with shell material.

I have also had a pipe which has been immersed in salt water for three years, taken up and broken. This pipe presented a moist appearance in the inside of the composition, but a close examination failed to detect any rust whatever. I enclose pieces of the wire taken out of this pipe, and if it reaches you as it leaves me, it will verify this statement. It must be understood that the composition used is very fine, and is applied in successive layers during the manufacture of the pipe, and the wire is ordinary steel or iron as the case may be—not galvanized. When the pipes are made, the wires are damped by the composition, and no doubt the surface is oxidized. That this oxidation does not go on is due, in my opinion as stated in the original paper, to the fact that there is no circulation of water or air in the composition. I have not thought it necessary to use galvanized wires, though this might be done. I cannot help thinking that if the oxidation were to proceed to a serious extent we should have it in a very marked degree in three years.

I write you on the matter on account of the interest you have shown in it, and may add that we are rapidly extending and cheapening this application of Monier work.

I am sir, yours faithfully, E. M. de Burgh,
M. Inst. C. E., Engineer for Bridges.

Public Works Dept., Sydney, May 13, 1901.

(The wires accompanying this letter show no evidence whatever of rust, and a thin film of the cement coating still covers them in many places. —Ed.)

An Unauthorized Publication of Engineering Drawings.

Sir: From time to time recently, designs of structural work have been published in the Engineering News at the instance of a Mr. H. G. Tyrrell, a former employee in the Estimating Department of the Boston Bridge Works. Several of these drawings and charts so published are identical copies of drawings belonging to the Boston Bridge Works, and a number of them Mr. Tyrrell had no connection with while in our employ. All such publications have been forwarded to you without our consent.

We had not intended to take any public notice of this matter, but our attention has been sharply called to the misleading nature of some of these publications, and we have been compelled to take legal steps towards enjoining further unauthorized publications of this sort.

It is hardly necessary to say that we attach no responsibility whatever to the Engineering News in the foregoing matter. Yours truly,

Boston Bridge Works, D. H. Andrews, Proprietor.

Boston, Mass., June 6, 1901.

(It is a long-standing rule of this journal that when matter involving a criticism of another person or firm is offered for publication, a proof of the article is sent to the party affected and an opportunity is afforded him to present a reply stating his side of the case, at the same time that the original criticism is published. In accordance with this rule, a proof of the above letter was sent to Mr. Tyrrell, and his reply is given below. It is proper for us to say that this reply does not at all meet the charge made by his former employer. Any engineer has an undoubted right to use his professional knowledge, however acquired, as he chooses; but he has no right to make public the private information, records or drawings, belonging to an employer without consent. On behalf of this journal, it should be said that Mr. Tyrrell's contributions were accepted and paid for by us on their merits alone, and we had no knowledge that the publication was without consent or authority until the receipt of Mr. Andrews' letter, above. Engineering News is always desirous of receiving first-class contributions on engineering subjects from working engineers, and it counsels a liberal policy on the part of manufacturing companies toward engineers in their employ who desire to contribute papers to engineering journals or societies. On the other hand, we recognize fully the legal right of all such companies to control their own affairs, and no contribution is acceptable, no matter what its merits, which makes public information that the author has no right to give. We comment at length upon this matter, believing that what we say may be of use perhaps to young engineers, ignorant of equities and customs in matters of this sort and likely to err through ignorance.

It is proper for us to add here that we have had in preparation for some time and have now in press a treatise by Mr. Tyrrell on "The Constuction of Mill Buildings." The proofs of this were submitted to Mr. Andrews on receipt of his letter above printed, and he has assented to the publication as it contained only matter which Mr. Tyrrell had a right to use. We refer to this matter here since some of our readers might suppose further publications by us from Mr. Tyrrell to be in disregard of Mr. Andrews' rights and as evidence, also, that Mr. Andrews has no desire to interfere at all with the proper use of engineering knowledge by his former employee, such as Mr. Tyrrell appears to have in mind in his letter which we print, as follows:—Ed.)

Sir: Replying to Mr. Andrews' criticism, it does not appear necessary for an engineer to consult the wishes of former employers as to what use he shall make of his engineering knowledge, even though that knowledge was acquired while in the employment of a company.

Yours truly,
H. G. Tyrrell, Civil Engineer.

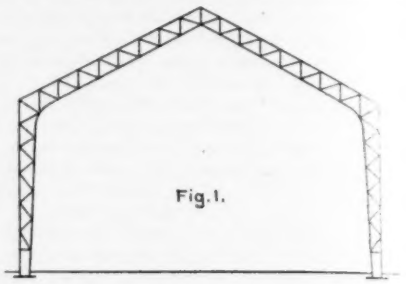
Boston, Mass., June 21, 1901.

Steel Buildings for Export.

Sir: I read with interest in your issue of April 11 the article on "Steel Buildings for Export," by Mr. H. G. Tyrrell, but found that, with the exception of the market building for Brazil, the design of the buildings does not differ from that customary for home buildings, nor was there in the design anything special for easiness in shipping or erection. They are perhaps styled steel buildings for export because the loads assumed are low and the stresses used in the determination of the sections rather high. At the last Paris Exhibition there were a great number of buildings to be seen, which were much more adapted for export than those shown on your plate. Fig. 1 shows the diagram of a typical frame of the exhibition buildings, and as can be readily understood, this sort of structures allows much more easiness in packing and transporting; takes much less room; is less liable to distortion from rough handling; is stiffer, and, what is very little known in this country, is much cheaper than any combination of columns with so-called French trusses, which are but very rarely to be seen in France.

I think the reason that these frames are not [illegible] often used in this country lies in the fact that the calc[illegible]on of such a two-hinged arch is a rather tedious [illegible]. The French method of calculation can be found in [illegible]ferent issues of "Le Genie Civil," for 1899.

These calculations can be very much simplifi[illegible] if we give the columns the same section throughout a[illegible] make also the rafters of the same section. If once th[illegible]rust at the bases is given the determination of the str[illegible] becomes as easy as that of a French truss, and the [illegible]mula



given below will enable any engineer, even if he is not acquainted with modern theories of elasticity, to design readily such frames.

The calculation must be divided into two parts: First, the calculation of the stresses from the vertical loads (dead load plus snow load) alone, and, second, that for the wind load alone.

Let Fig. 2 represent the diagram of the center line of such a frame;

I = moment of inertia of column (constant);
I_1 = moment of inertia of rafter (constant);
W = the vertical load on the roof in pounds; the other dimensions are in inches.

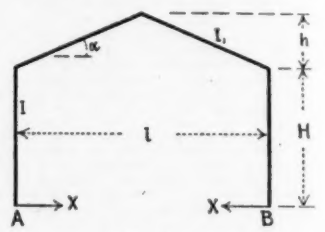


Fig.2.

Then the thrust at A or B from the vertical load is given by

$$X = \frac{1 + \frac{5}{8}\frac{h}{H}}{1 + \frac{h}{H} + \frac{1}{3}\frac{h^2}{H^2} + \frac{2}{3}\frac{H}{l}\frac{I_1}{I}\cos\alpha} \times \frac{W\,l}{12\,H} \text{ in lbs.} \quad (1)$$

If for any reason the distance of A B after erection is altered by the length $\triangle l$, the corresponding alteration of the thrust $\triangle X$ is given by,

$$\triangle X = \frac{2\,\triangle l\; I_1\; E}{l\; H^2 \left\{1 + \frac{h}{H} + \frac{1}{3}\frac{h^2}{H^2} + \frac{2}{3}\frac{H}{l}\frac{I_1}{I}\cos\alpha\right\}} \quad (2)$$

E = modulus of elasticity = 29,000,000 lbs.

$\triangle X$ is positive when l diminishes, and vice versa.

Let, in Fig. 3,

w = pressure of wind per inch run of column;
w_1 = pressure of wind per inch run of rafter;

the other denominations being the same as in Fig. 2

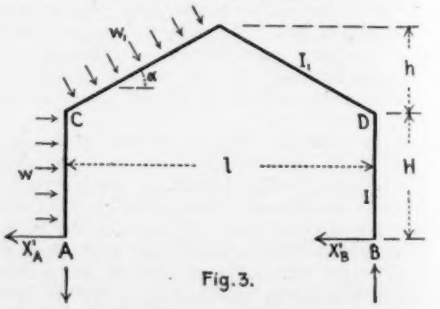


Fig.3.

Then the vertical reactions produced by the wind pressure at A and B are given by,

$$A = \frac{w\,H^2}{l} - \frac{w_1\,l}{2}\left\{1 - \frac{H}{4\,l}\frac{\lg\alpha}{\cos\alpha}\right\} \quad (3)$$

and

$$B = \frac{w_1\,l}{2} + A. \quad (4)$$

and the horizontal thrust at A and B can be calculated from the two equations:

$$X_A + X_B = w.H + w_1\,h. \quad (5)$$

and

$$X_A = X_B.$$

$$\frac{\frac{l_2}{I} + \frac{2\,l}{H}\left[1 + \frac{3}{2}\frac{h}{H} + \frac{2}{3}\frac{h^2}{H^2}\right]}{1 + \frac{h}{H} + \frac{h^2}{3H^2}} = \frac{l^2}{2H^2}\left\{1 + \frac{2}{3}\frac{h}{H} - \frac{1}{3\cos^2\alpha'}\left[1 + \frac{3}{4}\frac{h}{H}\right]\right\}$$

$$+ \frac{2}{3}\frac{H}{l}\frac{I_1}{I}\cos\alpha$$

$$\times \frac{w\,H^2}{4\,l}. \qquad (6)$$

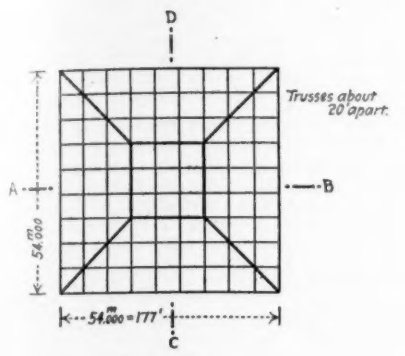


Fig. 4. Plan.

The greatest bending moment occurs in nearly all practical cases at C and D, which fact justifies the assumption that

$$I_1 = I. \qquad (7)$$

For this case and for a pitch $\frac{h}{l} = \frac{1}{4}$, as commonly made, $\frac{w_1}{w} = .58$ (by Hutton's formula), $\cos\alpha = .894$, and $\cos^2\alpha = .800$. I have compiled the values of the thrust for different relations of $\frac{H}{l}$ in the following table. With the aid of this table the design of such a frame does not take any longer than that of a French truss:

$\frac{H}{l} =$	¼	½	¾	1	5-4
X = W times.....	.22	.128	.077	.053	.0365
X A = w H times.....	.895	.882	.839	.805	.706
X B = w H times.....	.685	.308	.251	.340	.410

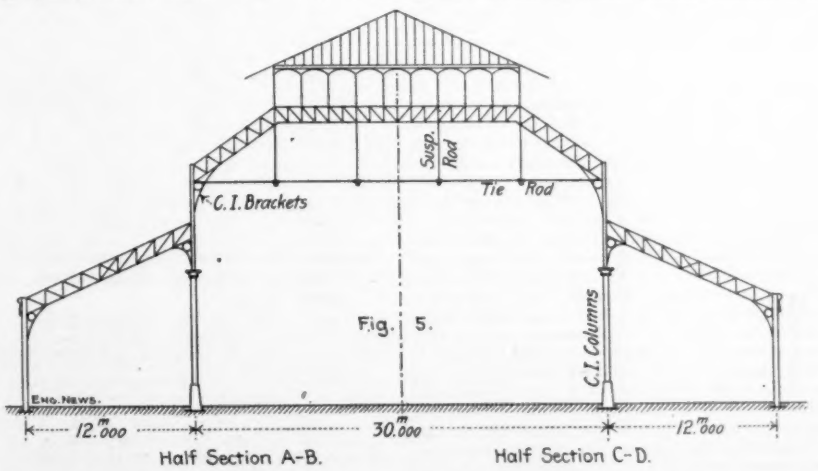


Fig. 5.

Half Section A-B. Half Section C-D.

For the adversaries of statically indeterminate structure I will mention that these formulæ were obtained by the same principles that the formulæ for the calculation of simple beams, freely supproted at their ends, are deduced, and that I do not know of greater uncertainty of stresses than in the web of a deep plate girder. As market buildings formed a large percentage of the buildings shown in your issue of April 11, Figs. 4 and 5, taken from the famous "Halles Centrales" of Paris, built in 1854, may show that the design of simple and elegant iron structures was well understood even fifty years ago.

Yours very respectfully, Leopold Mensch,
Civil and Mechanical Engineer.

237 West Van Buren St., Chicago, Ill.

Notes and Queries.

G. H. B., Brooklyn, N. Y., writes that he has always supposed it impossible to consume smoke after it has once been generated, and asks whether so-called smoke consumers really burn or destroy the smoke. It is true that the statement has frequently been made in treatises on combustion that smoke cannot be burned when once formed, and the idea has obtained wide currency. Like many other text-book statements, however, it is not true. Smoke can be burned if the proper conditions obtain. On the other hand, it is true that most of the so-called smoke consumers are really devices for insuring the complete combustion of the fuel without the production of smoke; this is undoubtedly the proper way to design a furnace, rather than attempt to burn the smoke after it has been formed.

ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

FIRST SESSION.

The 34th annual convention of the Association was held at Saratoga, N. Y., on Wednesday, Thursday and Friday of last week. The first session was held in the Theatre Saratoga on June 19, and was opened with prayer by the Rev. Dr. Joseph Curry. President Knapp, of the village of Saratoga, then delivered a brief address welcoming the convention to the village, which was suitably answered on behalf of the Association by Mr. Geo. W. West (N. Y., O. & W.). After same routine business, President W. S. Morris (Ches. & Ohio), read his address, which was of unusual length and unusually fruitful in ideas and suggestions.

President Morris reviewed briefly the growth of railway transportation, which he divided into: first, establishment; second, extension; third, improvement in the scope of the original conception, and, fourth, the introduction of scientific training into locomotive building, equipment and operation. The growth in the weight of passenger and freight locomotives was briefly outlined, and a plea made for a more decided recognition of the compound locomotive by the Association. In respect to boiler design, allusion was made to the extension of wide fire-boxes to engines using bituminous coal and to the development of a self-sustained fire-box very much on the lines of the Scotch marine boiler, and its successful use in locomotives. President Morris concluded his outline of the growth of the locomotive with the following pregnant remark:

Thus far the locomotive has advanced prominently in weight and capacity, or in other words, brute force. We now have before us the problem of making each ton of weight stand for the maximum possible horse-power, and in this there is much to be done. It will never be possible to improve the locomotive to a point in which it will compare favorably with the best marine and stationary service with regard to the number of pounds of coal per indicated horse-power per hour; but in the line of its present standing, as a machine which must run on the road and be relatively inexpensive to maintain, much may yet be done in increased economy in the use of steam.

Referring to the expedition of traffic, Mr. Morris said:

Among progressive methods which should be entertained prominently at this convention, is the necessity for improved facilities for quickly handling engines at terminals. Until recently it was thought that anything in the form of a roundhouse would suffice, but now the passenger engines are expected to make 100,000 miles, and freight engines from 40,000 to 50,000 miles per year. Roundhouses need more attention than was formerly given to shops, and this is brought about for the best of business reasons. There is scarcely any direction, except perhaps in economies in fuel, in which our work will bring more immediate and satisfactory returns than in prompt work at terminals. In busy times terminal conveniences are more readily realized and appreciated, because idle machinery for road service is shown to be so prominently unproductive, from the fact that the quicker and better the roundhouse works, the smaller the number of engines required.

The exact relative cost of fast and slow trains is to my mind less important than the advantage of high average speed—including time lost in stops. In other words, what is the cost of the needless delays on the road which render it necessary to run unduly fast between stations? Most trains stop unnecessarily long at stations. They must sometimes wait six, eight, or ever more minutes for water to run into the tender tanks througr a small pipe, where one or two minutes is long enough where pipes are sufficiently large for the delivery of the water. Trains are slacked up for dangerous places, which would be passed at high speed if equipped with signals. It is difficult to realize that a minute lost at a station is the same as one lost while running, yet that is the fact, and delays at stations necessitate faster running, and consequently a relatively higher cost in operation.

The report of the Secretary showed the membership of the Association to be 680. The receipts during the year were $4,304.98, which left a balance of $240 after all expenses were paid. The total balance now in the hands of the Treasurer is $3,712.90. The Secretary also reported that the dues for the ensuing year had been made $5. Under the head of new business, several proposed modifications of the Constitution and by-laws were voted upon and adopted. It was also voted to elect to honorary membership the following early members of the Association: Messrs. Henry A. Sprague, a member since 1868; Reuben Wells, 1868; D. O. Shaver, 1868; William Swanston, 1868; J. H. Setchel, 1869; J. M. Boon, 1869; John Hewitt, 1871; W. H. Lewis, 1873; W. A. Foster, 1875; Allen Cook, 1879; J. M. Scheer, 1891; L. B. Paxson, 1895. The next business was the reading and discussion of special committee reports.

THE RELATIVE MERITS OF CAST-IRON AND STEEL-TIRED WHEELS.

The report of the committee upon this subject was in effect that no new developments had taken place since its previous report and that it had nothing of further value to present.

DISCUSSION.—The only remarks upon the report were made by Mr. R. P. C. Sanderson, who presented the results of a calculation made by him to determine the relative cost of cast-iron and steel-tired wheels, taking into account the relative interest charges and the relative periods of service. In this calculation steel-tired wheels were assumed to cost $45 and to run 300,000 miles, and cast-iron wheels were assumed to cost $8.50 and to run 50,000 miles. Mr. Sanderson summarized his calculations and results as follows:

I have taken the cost of ten steel-tired wheels up to the time when the first turning becomes necessary, adding on the accrued interest from year to year, then adding the cost of turning and replacing and again carrying forward the interest, again adding the charge for the second turning and replacing, etc., up to the time when the wheel is to be removed either for scrapping or for repairs. The net cost for service for 3,000,000 miles, that is, ten times the life of the wheel mileage, would be $1,071.43, or 35.714 cts. per thousand miles. For the corresponding mileage to be gotten out of cast-iron wheels, on the basis of the figures mentioned, the cost would be $580, or 19.689 cts. per thousand miles. Assuming the same set of conditions, but the first cost of the steel-tired wheels at $55 instead of $45, and assuming that the $55 wheel could be re-tired repeatedly, and allowing credit for the second-hand centers, as three-quarters worn out at the end of the life of the first tire, the cost of steel-tired and of cast-iron wheels came to nearly the same. There is a difference of only $27 between the cost of service for the wheel which would be scrapped at the end of its life and for the wheel which would be re-tired. Consequently it looks as if there were a distinct advantage in buying a high-priced wheel and re-tiring it if you care to figure what the other fellow who is going to succeed you is going to do. You will have at the end of 18 years and 9 months in one case a wheel to be scrapped, and in the other case a wheel which is perfectly good, and the cost of the service in the meantime will be the same.

TON-MILE STATISTICS.

The committee upon this subject presented no formal report, but Mr. H. C. Quereau (D. & R. G.), a member of the committee, spoke at some length in opposition to the comparison of ton-mile statistics on different roads as being unfair to motive power officials and in advocacy of the inclusion of the locomotive ton-mileage in the total ton-mileage. The substance of his argument was embodied in the following resolutions, which were adopted by vote of the convention:

Resolved, That it is the sense of this convention that a strict comparison of motive power statistics, one with another, will not secure the best results, but that such comparison should be made with the same division for preceding periods of time.

Resolved, That it is the sense of this convention that the ton-mileage of the locomotive is a just credit to the motive power department for statistical purposes.

A CLASSIFICATION OF LOCOMOTIVES.

This was an individual paper by Mr. R. P. C. Sanderson, and was in abstract as follows:

For an engine classification to be generally useful it should fill the following requirements: (1) It should give an immediate mental picture of the style of engine; (2) it should give correct information as to the power of the gine; (3) it should designate, for the benefit of the Mechanical Department, foreman and others, the particular make of engine.

To comply with the first requirement it has seemed that the initial letter of the recognized names of the different types of engines would be the best class letter to use, thus:

E for 8-wheel engines; T for 10-wheel engines; V for 12-wheel engines; C for consolidation engines; M for mogul engines; S for switch engines; A for Atlantic type engines; P for Prairie type engines.

If such class letters are used, any railroad man speaking the English language can tell at once, as soon as he sees the class letter, which style of engine is referred to.

With reference to the second requirement: It is suggested that for this purpose we could use the hauling capacity in tons at ten miles per hour on a straight, level track, figured under formula $H = \frac{T}{R} - W$, where "T" equals tractive force in pounds, figured by the usual formula on a basis of 80% of boiler pressure as mean effective pressure; "R" representing 5.25 lbs., equal to the speed resistance per ton, and "W" the weight of the engine and tender in tons. This would figure out anywhere from say 2,400 tons to 7,500 or 8,000 tons, ranging from a 17-in. cylinder to a 22-in. cylinder. As these figures will

be too long for current use, and as minute refinement is unnecessary, it is believed that the first two figures, representing hundreds, would be sufficient, so that an engine classed as "T 37" would represent a 10-wheel engine of 3,700 tons hauling capacity on a straight, level track at ten miles per hour.

This would give the transportation officers all the information they would require with regard to any engine that would appear on their divisions. They would need in addition a rating sheet for each division showing—at the speeds at which the trains would have to be handled, and making allowance for all the difficulties of the division, water stops, grade stops, compensation for curvature, etc.—what the actual tonnage rating should be summer and winter for each tonnage class as given in these figures.

The Mechanical Department officers, however, will have to have further knowledge of the engine in that there might be several different patterns of engines of the same type and tonnage class. There might be, for instance, three or four styles of engines "T 37." This can be very readily provided for by using a small letter affix to follow the tonnage rating, as "T 37 a," and "T 37 b," and so on, representing different builds and makes of engines of the same tonnage class and type.

With regard to switch engines, they are not usually figured on the basis of tonnage rating. As some further knowledge of the engines is desirable, it is therefore believed that the switch engines can be classified in the following manner, to convey a better impression of the style and class of engine: S 4, 4-wheel coupled switch engine, no truck; S 6, 6-wheel coupled switch engine, no truck; S 8, 8-wheel coupled switch engine, no truck; S T, 10-wheel switch engine; C S, consolidation switch engine, S M, mogul switch engine.

DISCUSSION.—The discussion was opened by Mr. F. F. Gaines (Lehigh Valley), who criticised the initial letter designation of type as not being flexible enough, since it did not provide for future development. He also thought that the designation for tonnage rating should be omitted entirely from a general classification. Mr. F. M. Whyte (N. Y. C. & H. R.) called attention to a classification system based upon the arrangement of the wheels in each type of engine. Thus, an Atlantic type locomotive would be designated as a 4—4—2 locomotive, which, translated, meant an engine with four truck wheels, four driving wheels and two trailing wheels. This classification could be used for general correspondence, but could not be adopted by individual railways with entire success for their individual purposes. Mr. Geo. L. Fowler spoke in advocacy of Mr. Whyte's system as being based upon simple principles, and as being universal in its application. Mr. Angus Sinclair considered that the system proposed in Mr. Sanderson's paper afforded a more comprehensive index to the various characteristics of a locomotive which it was desirable to know than any other, and he favored it in comparison with any numerical system based upon wheel arrangement. After some further discussion the question was voted referred to the committee on subjects for consideration among the subjects to be allotted to committees for report at the next convention.

TOPICAL DISCUSSIONS.

In accordance with the customary practice of the Association, the noon hour of the session was devoted to short discussions of topics suggested by the members. Two subjects were suggested: (1) The Proper Method of Lubricating Locomotive Driving and Truck Axels, and (2) Should Parallel Rods be Left in Position on Locomotives While in Transit?

(1) The discussion on the first topic was opened by Mr. G. R. Henderson, who severely criticised the common method of driving-axle lubrication, and said:

Various remedies have occurred to me which are, perhaps, more or less unsuited to the actual requirements of the case. One was to keep the bearings continually flooded with some cheap lubricant, something like the fluid we use in our shops for drilling compounds, which could be used in large quantities and allowed to run off on the track without attempting to collect the same. Another method, which has been tried on a small scale and is now being experimented with, is of the type designed by the McCanna Lubricator Co. This consists of a force pump operated by a chain from one of the driving axles forcing oil absolutely through the pipes to the driving bearings and the truck bearings. Of course in this case regular oil is used and is dealt out in small quantities in accordance with the needs of the engine. It seems that we might go still further into this and instead of using a deep cellar filled with waste that we might have a shallow cellar of some soft metal that could be allowed to bear up tight against the box and the axle and catch the oil that drips through from the overhead space. This would act as a shallow pan and the motion of the engine would probably allow the oil to splash up against the journal from underneath. Just how satisfactory this would be I am unable to state, as I have not tried it, but the suggestion has come to me from other sources as well as my own thought, and it is possible that there may be some field for experimenting in this direction. Even with the very best of care that it is possible to give a locomotive, the bearings are liable to give trouble.

Mr. Geo. W. West (N. Y., Ont. & W.) considered that the majority of hot boxes were caused by the working of the packing between the journal and bearing, and not from lack of lubrication. Mr. G. W. Rhodes (B. & M. R.) believed that a very efficient remedy for hot boxes consisted simply in providing covers to the oil holes to keep dust out and in using good oil and plenty of it. Mr. J. L. Lawrence (Cumb. Val.) thought that master mechanics were inclined to slight the workmanship in fitting driving boxes onto the axles. More care in this respect, together with the use of more oil and oil of a better quality, would, in his opinion, do away with much of the trouble at present experienced. Mr. R. P. C. Sanderson stated that some years ago there was in use on the Atlantic, Mississippi & Ohio Ry. a patented bearing which consisted of some slots cut in the top of the brass, combined with flat wicks passed down through the slots into the cellar, which fed oil to the top of the brass by capillary attraction. This device worked very successfully.

(2) The second topic was introduced by Mr. Wm. Garstang (C., C. & St. L.), who stated that it had been his practice for some time to have engines shipped with the side rods connected up. The advantages to be gained were time saved in getting the engine into service, certainty that the rods had been properly fitted at the locomotive works, and less danger to the track from the impact of unbalanced driving wheels. Several other members presented evidence in support of Mr. Garstang's claims, and upon motion it was voted to be the sense of the convention that side rods should be on the engines in traveling from the works to the railways for which they were built.

SECOND SESSION.

The second day's session opened with a considerably increased attendance. The convention proceeded at once to the reading and discussion of special committee reports.

COST OF RUNNING TRAINS AT HIGH SPEED.

The bulk of this report consisted of a record of tests made by the Chicago & Northwestern Ry. on its locomotive-testing plant and of a record of a rather elaborate road test of a fast and a slow train on the Chicago, Burlington & Quincy R. R. From these data and the answers received to its circular of inquiry, the committee reached the following conclusions, which it acknowledged to be rather unsatisfactory:

The cost of operating high-speed trains where they make few stops between terminals, as compared with the cost of operating heavy trains making frequent stops, is usually a matter of guesswork. In the case of a heavy train making frequent stops, the speed between stations is nearly, if not quite, as high as the speed of the fast train, but the boiler is of course not taxed so severely as when it is required to furnish power continuously.

The tests made by the Burlington road are of great value so far as they go, and clearly indicate that, so far as coal consumption is concerned, it is fair to assume that the cost increases directly as the speed increases, but your committee realizes that this is only one of the items of the enhanced cost of running trains at high speed.

The greater capital invested in locomotives capable of handling trains at high speed, the greater cost of maintenance, represented in the greater care and more perfect inspection, is spoken of by all who have replied to our queries. Furthermore, it is a pretty generally acknowledged fact that any given class of power will show far more engine failures operated at high speed than at lower speed; that the "keying up" of the service on a few trains tends to key up the service of all trains, and that while there is an undeniable benefit resulting from the greater alertness on the part of employes, there is an expense resulting from these greater demands on engines, requiring more expensive motive power, from machinery failures in both engines and cars, resulting from this greater speed, more serious results from derailments or accidents when they occur, or which involve an expenditure of money to prevent.

Your committee has only considered the question of cost of running trains at high speed as affected by mechanical considerations. None of the other features of the problem, such as cost of track maintenance, cost of keeping the track clear, keeping trains out of the way of high-speed trains, and many other incidentals, have been considered at all.

DISCUSSION.—The discussion was opened by Mr. G. W. Rhodes (B. & M. R.), who called attention to the conclusion of the Chicago, Burlington & Quincy R. R. tests, namely, that the fuel consumption increased directly with the speed. If this were true and since the drawbar pull increased with the speed, it was evident that high-speed trains were a very expensive sort of transportation for a railway to provide. Mr. F. M. Whyte (N. Y. C. & H. R.) referred to the conclusion regarding fuel consumption, which was drawn from the C., B. & Q. tests. He thought that if the locomotive for high speed were as well designed for high speed as the slower locomotive was designed for slow speed the economy of the boiler should be about the same. This being so, the coal consumption should vary with the train resistance, or what was the same thing, with the speed. It happened, and, he thought, merely happened, in this test that at the speed selected the coal consumption corresponded to the curve of resistance; that is, that the coal consumption at 30 miles per hour was about one-half what it was at 60 miles per hour, and that the resistance at the two speeds varied in the same proportion. If, however, we multiplied the coal consumption at 20 miles per hour by three we should get a result entirely different than was shown by the test. All that could be said of the test, he thought, was that the coal consumption at 60 miles per hour was twice as great as at 30 miles per hour. Mr. Whyte also criticised the Chicago & Northwestern Ry. tests as giving results which did not agree among themselves. Mr. F. A. Delano (C., B. & Q.), in answer to Mr. Whyte, called attention to the fact that in the tests made on the Chicago, Burlington & Quincy R. R., the results secured seemed to check. At 60 miles per hour the fuel consumption, the drawbar pull and the combustion per square foot of grate were all practically double what they were at 30 miles per hour. He believed that fast trains had come to stay, but he thought also that it should be fully comprehended that fast trains cost more to run than did slow trains. Mr. T. H. Symington disagreed with any conclusion that it took twice as much coal if the speed of the train were doubled. Referring to the C., B. & Q. test, the results showed that the drawbar pull at the slower speed was about one-half what it was at the higher speed. The product of the drawbar pull by the distance would to some extent indicate the amount of work done between the two terminals, and he thought that all that the [illegible] proved was that the engine on the slow-speed train [illegible] orking very much more economically than that on the [illegible]-speed train. He had seen high-speed trains run wher[illegible] coal consumption was but very little in excess [illegible] that of slower-speed trains. The secret of this was in [illegible]g the engine suited to the service in each case. Th[illegible] reased cost of high-speed service existed mainly in th[illegible] reased cost necessary to provide engines adapted to th[illegible] rvice. He did not think that engine maintenance and [illegible] spection increased in cost in proportion to increased [illegible]. To summarize, therefore, he believed that increased [illegible] due to high speeds was on account, first, of increased [illegible] cost of engines, second, a slight increase in fuel con[illegible]ption, and third, in increased transportation expen[illegible]. Mr. Pulaski Leeds (L. & N.) contended that both [illegible] fuel consumption and the cost of maintenance of lo[illegible]otives were materially increased by increasing the spee[illegible] train service. The discussion was closed by vote of [illegible] convention that the committee be continued for anot[illegible] year, with instructions to continue its investigations [illegible]nd to report the results at the next convention of the As[illegible]ation.

THE MOST SATISFACTORY METHOD OF HANDLING, CLEANING AND SETTING BOILER TUBES.

The report upon this subject was of chief interest for the detail in which it set forth the sequence and character of the various operations involved in the expeditious and economical handling, cleaning and setting of locomotive boiler tubes. Slightly condensed it was as follows:

Tubes should be cut out of both tube sheets with a power cutter and removed through dry pipe hole, providing the pipe has been taken out, otherwise through a tube hole that has been reamed sufficiently large to admit of removal of tubes, according to the probable amount of hard scale they may carry. The ends remaining in the front sheet should be driven out with a pneumatic hammer and chisel. The ends remaining in back tube sheet should be removed in a similar manner. A heavier hammer, however, is needed for this, with an ordinary flat chisel about ½-in. wide, or a split calking tool. The labor of chipping off beads can be then dispensed with. They should then be taken to the rattler for the purpose of removing the scale. Safe ends should be cut off and scarfed and piled near furnace with horning anvil, where the tubes should be opened and safe end applied. After this operation they should be piled convenient to welding furnace.

The safe end should be same thickness as original tube

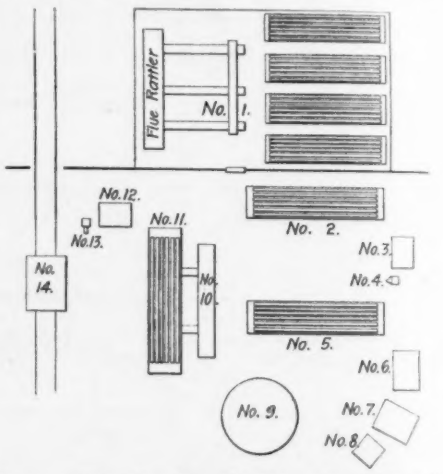


Diagram Plan Showing Arrangement of Plant for Handling, Cleaning and Setting Locomotive Boiler Tubes.

1, Rattler and tube storage room outside of shop; 2, Tube rack for tubes taken from rattler room; 3 and 4, Heating furnace and horning anvil for expanding ends and sticking safe ends; 5, Tubes racked after safe ends have been applied; 6, Welding furnace; 7, Welding machine; 8, Pneumatic swaging machine; 9, Lime pit for annealing; 10 and 11, Cutting-off machine with circular disk cutters and rack for tubes after being cut to length; 12 and 13, Furnace and horning anvil for opening front ends of tubes; 14, Push car for receiving finished tubes.

and should be applied to the end of tube having previously received a safe end in order that the thicker end of tube be used for welding. After weld has been made and scale scraped off, the tubes should be swaged about 5-32 in. and stood up in quicklime for annealing. They are then cut to length, and front end opened on horning anvil and are then ready to be replaced.

The committee is of the opinion that, with the average workman, it is not necessary to test the welds in tubes until they have been reset, for, with the small percentage of failures, it is more economical to remove a defective tube occasionally after having been set in boiler than to test each tube separately.

Before setting tubes, copper ferrules should be rolled into the holes of the back tube sheet and tubes driven into them. The back ends of tubes should be set with a Prosser expander and after peening over, rolled with a roller expander and beaded with a pneumatic hammer and beading tool. The front ends should be rolled with a roller expander.

The heating of tubes is accomplished with either coke, anthracite coal or oil. Either of these will produce a satisfactory welding heat, and the furnace should be arranged for heating as many tubes simultaneously as the man at the welding machine can handle without waiting for a heat. The fuel used is rather a matter of cost, according to local conditions, than of specific kind.

The rattler should be hexagonal, or if of large diameter, octagonal in shape. One section should be secured by key bolts, that it may readily be removed by means of a

pneumatic lift. By giving the rattler a half turn, all the coal will be discharged at one operation upon an inclined plane in order that they may roll clear of the machine. Where coal or coke is used it should be fed to the furnace by means of a hopper. In case of burning oil, it should be supplied with a burner at both ends, especially where tubes are being heated from both sides of the furnace.

The committee recommends the scrapping weight of tubes for boilers carrying 200 lbs. boiler pressure as follows: 2-in. tubes, 1.65 lbs. per foot; 2¼-in. tubes, 1.85 lbs. per foot. From this it is obvious that a heavier tube will have a greater percentage of service metal.

No definite information was received regarding the merits of steel tubes as compared with charcoal-iron tubes. The experience with steel tubes seems to have been very limited. The opinion of the majority favored charcoal-iron tubes from the fact that they pitted less and would hold a better bead. The principal trouble, however, was in the welding of steel tubes to steel safe ends. The committee is not prepared to say how much of this is due to the inexperience of the operator or to the metal itself.

The arrangement of plant recommended by the committee for carrying out the work described is shown in the accompanying diagram plan.

DISCUSSION.—The discussion of this report consisted largely of expressions of individual experience and practice respecting the various details of the work described. Mr. David Brown (D., L. & W.) stated that he found advantage in using safe ends having the metal a gage thicker than the tubes. He considered oil the preferable fuel, since the tube required cleaning less frequently. Mr. A. Forsyth stated that he had found a flux of water glass (silicate of soda) and borax to answer well in welding steel tubes. Mr. A. E. Mitchell (Erie) stated that his shops regularly welded steel tubes to iron safe ends without difficulty, and Mr. Wm. Garstang (C., C., C. & St. L.) stated that he found no difficulty in welding steel tubes to safe ends of either iron or steel. Mr. G. W. Rhodes (B. & M. R.) called attention to the pitting of steel tubes as a difficulty which he had experienced. Mr. John Platt stated that experience in marine boilers of the Thornycroft type had shown that steel tubes would often pit seriously. The builders of these boilers had never been able to discover the reason for this. Such pitting was not, however, universal, but would occur in one case and not in another, without any apparent reason for the result in either case. The reason why locomotive builders had trouble in welding steel tubes was, he thought, due to lack of care in securing uniform annealing; some tubes were hard and others were soft. Mr. T. A. Symington considered that the best way to prevent leaking tubes was to purify the boiler feed water. Mr. Wm. McIntosh (C. R. R. of N. J.) described a method of setting tubes to prevent leakage, which was as follows:

In the first place, the flue holes of the sheet should be round. They had a tendency to become oblong by working, and it is necessary to ream them out when they get in that condition. Then the ferrule comes next. That should be made as short as possible, having it come about to the face of the sheet on the fire side, and project barely enough on the water side to hold it, say 1-32-in. Then reduce the flue so as to make a tight fit in the ferrule, and after it has been rubbed off either with emery stone or a file to remove the scale, drive your tube into the sheet with some force, two or three good blows. Allow it to project through and then use a heavy hammer and upset it, instead of turning it over, as is frequently done. Around the face of the flue hammer it slightly towards the ferrule and upset it all the way around, and in this way you thicken the metal at that point and finally finish to a solid bead. Then finish slightly with rolling.

Mr. E. A. Miller (N. Y., C. & St. L.) considered that one of the most prolific causes of leaky flues was the cooling down and rapid heating up of the boiler while lying on the side track during waits in transit. Mr. W. Cross (Can. Pac.) had found that pitting and leakage were chiefly troublesome when poor boiler feed water had to be used, and that they were practically nil where good water was used. Mr. Roberts (L. & N.) had found considerable advantage in reaming the flue holes to a taper when resetting tubes.

WHAT IS THE MOST PROMISING DIRECTION IN WHICH TO EFFECT A REDUCTION IN LOCOMOTIVE FUEL CONSUMPTION?

The discussion of this report (which is printed on another page of this issue) was opened by Mr. G. W. Rhodes (B. & M. R.), who stated that in his opinion one of the most fruitful opportunities for saving in fuel lay in preventing waste from coal dropping off the tenders and through the gangways. He believed that a man would save many times his salary to a railway by following up and preventing waste of this sort.

Mr. R. P. C. Sanderson endorsed what Mr. Rhodes had said, and called attention to the advantage of keeping individual coal records. Those who had kept such records and had studied them had noticed that men doing the same service, with the same engines, with the same trains, and schedules, and speeds, and all the other conditions the same, varied greatly in their coal consumption—often as much as 100%. It had always occurred to him that the matter of educating the men in the economical use of coal had more in it in the way of economy in coal consumption than any of the devices which could be applied to an engine. If we could bring the men with the poor records by training and pressure up to somewhere near the men with the good records the average saving would be large and the cost of making it comparatively insignificant. The committee had referred to the question of cylinder clearances. Their argument seemed to him to be rather fallacious, especially at high speeds. In the indicator diagrams of locomotives at high speeds with which he was familiar the compression generally ran up to the steam line and not infrequently beyond it. If the clearance in the cylinder were made smaller that compression would probably be still greater and would be a disadvantage instead of an advantage, at least in high-speed work. Reference was made in the report to the compound engine. He had some hesitancy in opening this question. He indorsed the compound principle when properly applied, but there were kinds of service when the compound engine was not, he believed, as economical as a simple engine. On a railway where the grade was practically uniform—nearly level or extremely heavy—and the engine could work during a large proportion of its fuel consumption at a definite rating of power for which it was originally designed, there was no question but that the compound engine was the proper one to use. Where, however, there was a varying profile, or where you wished to change your engines from one division to another continually, and where one division was suited to the compound and another not suited, he very much doubted whether the compound engine would be as successful as a well-designed simple engine.

Mr. C. M. Muchnic (Baldwin Locomotive Works, London Office) called attention to the fact that in Europe the railways had a premium system in operation; each engineer was allowed so much coal per kilometer, and he was rewarded by increased wages for any reduction in this amount. Some engineers made $60 to $70 per month in this way. They had been using feed-water heaters on the continent for several years with very good results. As regards compound engines, most railways on the continent used them for fast passenger service, hauling very heavy trains, and saving largely in fuel.

Mr. Potter (Union Pac.) took issue with Mr. Sanderson's statement that the compound engine was not of uniform economy. The Union Pacific had for the past year or so been making special effort to secure fuel economy, and among other things had tried compound engines, traveling firemen and special fire doors. They had not yet tried wide fire-boxes, but expected to do so, and expected a saving from them. It seemed to him that the compound engine was uniformly economical, although he would agree with Mr. Sanderson to this extent, that there were some conditions in which they were more economical than in others. These conditions were where the engine was working continuously as compared with conditions where they would drift a part of the time. He believed that the wide fire-box would come second to compound working as an economizer of fuel. Mr. A. L. Humphry (Colo. & So'n) and Mr. Wm. McIntosh (C. R. R. of N. J.) mentioned as particularly advantageous the keeping of individual records of fuel consumption, as an incentive to the men to reduce the amount of fuel used on engines.

Mr. M. N. Forney stated that he had long been an agnostic on the subject of compound locomotives. He did not take the ground that there was no economy in compound locomotives, but he thought that the total cost in many cases was greater than could be made up by any economy in fuel. There were occasions in which it seemed advisable to use compound locomotives, and there were other conditions in which it seemed extremely inadvisable to use them. The compound locomotive designer always claimed the right to use a heavier boiler than was used in a simple engine of corresponding size. If he was given the same right he would design a simple engine of even greater economy. He considered that the difficulties in the way of using feed-water heaters were very great. The principal one was to get enough heating surface to heat the water to any considerable temperature, and find room for it on the locomotive. Another difficulty was that the pipes used soon get filled up with scale and the heater became useless.

Prof. W. F. M. Goss (Purdue University) considered that the statements in the report regarding cylinder clearances were not correct in the impression conveyed. It was implied by the table that the clearance steam was all waste. This was not true. Should the engine be cut off at the beginning of the stroke, all the steam admitted to the cylinder would be admitted to the clearance space, and yet the engine would run, as the steam would do work through expansion. He thought that there was often a loss of steam through leakage by defective valves. He had found in testing stationary engines under absolutely uniform conditions that two firemen would vary 25% in the amount of fuel used to do the same work. What then must be the variation at times in locomotive engines due to this cause?

A PRACTICAL TONNAGE RATING.

This paper by Mr. Geo. R. Henderson (A., T. & S. Fe.) was mathematical in character, and rather too special in its scope to be of general interest. Briefly described, it gave rules and diagrams for rating engines for any profile and alinement of road. The discussion was brief, and turned upon the relative rating that should be given for loaded and empty cars.

MAXIMUM MONTHLY MILEAGE.

The committee considered that the factors controlling and limiting mileage might be grouped into three classes, with subdivisions, as follows: (1) Physical nature of the road, (a) length of divisions, (b) character of grades and curves, (c) number of stops necessary; (2) transportation methods, (a) schedules, (b) number of trains run, (c) variation in traffic, (d) condition of equipment; (3) motive power methods, (a) system of crews, (b) roundhouse practice, (c) system of running repairs, (d) adherence to standards. Statistics were collected on each of these points, and a study of them led to the following conclusions as the best means for obtaining a maximum monthly engine mileage:

PHYSICAL NATURE OF ROAD.—That short divisions be lengthened so that the average service will consume from eight to ten hours over the division one way.

That there be as low a maximum grade and degree of curve as practicable, and that helping engines be placed at one or two points on a division where the grade is considerably in excess of the rest of the division.

That unnecessary stops be eliminated as far as practicable by the better location of water columns.

TRANSPORTATION METHODS.—That as far as practicable schedules be arranged to give reduced layover away from the home terminal.

That crews be required as far as practicable to live at the point most conducive to economy of operation, and to keeping engines in service.

That transportation officers avoid the demand for more power when during a short heavy season some other requirements of the service can be adjusted temporarily, thus avoiding the laying up of engines in normal season.

That transportation officers do not make the demand for all engines to be in good order, resulting sometimes in the purchase of new power for heavy seasons, when it might be avoided, and thus provide for increased mileage in normal seasons.

MOTIVE POWER METHODS.—That engines be double-crewed with extra men for relief when there is enough work on one engine for two men. When this is not the case, that they be single-crewed with extra men for relief.

That special attention be given to the roundhouse force and equipment, and that it be the last place to suffer from reduction of force.

That the very best talent in the machinery department be placed in charge of the roundhouse work, and that system alone be not depended on for results.

That the inspection of engines be reported separately by the enginemen and inspectors, as a check on their attention to detail.

That the roundhouse work be specialized as far as possible so as to avoid a division or uncertainty of responsibility.

That the existing methods be overhauled so that necessary routine work will not cause engines to lose their turn.

That with the change to the pooling system, adequate preparation be made for more careful inspection, and heavier charges to maintenance.

That interchangeability of parts be adhered to as far as practicable in various types of engines.

That we strive after simplicity of design, and adhere to what we know is all right, unless there are excellent reasons for change.

DISCUSSION.—The discussion relating strictly to the report was brief, and consisted mostly in commendatory remarks concerning the work done by the committee. It was followed by a rather rambling and irrelevant discussion of the advantages and disadvantages of pooling locomotives.

TOPICAL DISCUSSIONS.

During the noon hour Mr. Wm. McIntosh (C. R. R. of N. J.) introduced the question of the design of piston followers, bull ring and packing ring that would obviate the necessity of removing the piston to change the rings. The discussion was brief and furnished no solution of the problem. The subject of the Best Material for Crank Pins was suggested by Mr. John Mackenzie (N. Y., C. & St. L.), and was discussed by Mr. A. L. Colby, of the Bethlehem Steel Co., who advocated the use of nickel steel. Mr. Colby stated that his company had records of 2,419 crank pins furnished to railways with no record of a failure in any case.

THIRD SESSION.

After some brief routine business, the convention resumed the reading and discussion of special committee reports.

THE MOST IMPROVED METHOD OF UNLOADING LOCOMOTIVE COAL PRIOR TO ITS BEING UNLOADED ONTO THE TENDER.

The bulk of the report consisted of drawings of representative coaling stations, to which the text of the report referred briefly. It was the opinion of the committee that the expense of coaling engines was governed entirely by the kind of cars in which the coal was handled, provided the coaling station was one that would admit of dumping the coal to either bin or conveyor. If the coal was received in hopper bottom or side-dump cars, the cost would probably be between 1 ct. and 3 cts. per ton delivered on the tender. If the coal were received in gondola or box cars, and had to be shoveled from the car, the cost would be from 6 cts. to 8 cts. per ton delivered on the tender. Of the plants illustrated, there were four which commended themselves to the committee as having special advantages and as covering all general conditions. These were: (1) A cheap station operating gondola or coal cars, and using a bucket operated by a pneumatic crane as a means of measuring and transferring the coal, Fig. 1. (2) The single or double pocket of large capacity delivering coal directly to the tender or from a measured car of small capacity, Fig. 2. (3) The large pocket with a weighing dynamometer, Fig. 3. (4) The measured pocket with storage underneath, Fig. 4.

DISCUSSION.—The discussion was opened by Mr. G. W. Rhodes (B. & M. R.), who pointed out that the essential feature of the bucket plant mentioned first in the report was the power-operated crane. Without the pneumatic crane this was about the worst method possible for handling coal. He thought that a mistake was being made in locating main coaling stations at roundhouses; they should be located on the main line, so that an engine would not need to waste time in disconnecting and run-

ning to the roundhouse. The coaling stations at the roundhouses should be minor affairs for the use of switch engines. The great object at present was to get mileage out of the locomotive, and the main track coaling station was an aid to this end.

Mr. A. M. Waitt (N. Y. C. & H. R.) stated that according to figures which he had compiled he had found that the cost of handling coal ran from 1.4 cts. per ton at the most economical plants to 41 cts. per ton at the antiquated and most expensive plants. Where space was limited, mechanical coaling plants were almost a necessity. The cheapest method used consisted of an inclined trestle track leading to elevated pockets on both sides of the track from which the coal was discharged into the tender by means of chutes. At some of these plants the cost of handling coal ran as low as 1.4 cts. per ton. Several forms of mechanical plants were operated, but he could not say which were the better. At some of them the best records showed a cost for handling of only 3.26 cts. per ton, but others showed a cost as high as 7 cts. per ton.

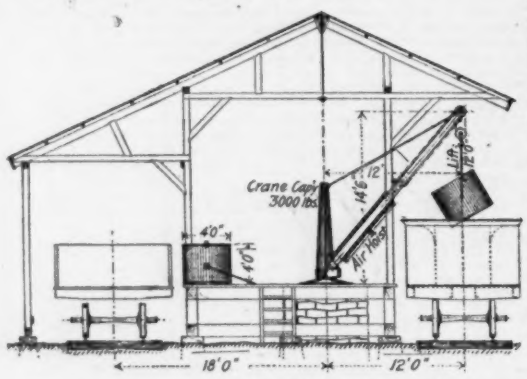


Fig. 1. Standard Small Coaling Station with Pneumatic Crane; Cleveland, Cincinnati, Chicago & St. Louis Ry.

Mr. F. A. Delano (C., B. & Q.) regarded the second form of station selected by the committee as perhaps the most satisfactory one. At times, however, its installation involved some rather difficult problems. In order that the coal should flow freely from the car into the pocket and from the pocket into the tender, the track had to be about 36 ft. above the ground. This necessitated a very long trestle approach if the cars were to be handled by switch engines. When cramped for room some other means was necessary for handling the cars. Cable haulage had been suggested, but this involved a very large cable. He was disposed to think that, with an incline of 25% to 30%, an especially-designed rack locomotive would be found the best means. In the West the run-of-mine coal contained very large pieces, sometimes weighing half a ton. It was his practice to break this large coal before admitting it to the pockets. To do this they covered the pocket with a grating of parallel bars measuring 1 in. × 5 ins., set on edge about 5 ins. apart. The coal was dumped from the cars onto this grating, which passed the smaller sizes and retained the larger, which were then broken by mauls until in small enough pieces to pass between the bars. For weighing the coal delivered to the engines, he had recently inaugurated a track scale system. These scales were 20 ft. long and were located near each end of the pockets, two being used for a single line of pockets and four for a double line. The tender approaching the pocket was first weighed empty, and upon leaving the pocket was weighed full. These scales had been in use for over a year with satisfaction.

Mr. A. E. Mitchell (Erie) had about every kind of coaling station, buckets, inclines and link-belt plants. At Jersey City, N. J., and Port Jervis, N. Y., link-belt plants were used. In these plants he was able to mix the fine anthracite, such as washed, bird's-eye and barley coal, with bituminous coal. His mixture was composed of 70% anthracite and 30% bituminous, and cost from 50 cts. to 60 cts. per ton. The object of adding the bituminous coal was to make a coke which prevented the fine anthracite from falling through the grates. The cost of handling coal at his plants ran from 3 cts. to 9 cts. per ton. The coal was free from water, and no trouble had been experienced with the freezing of the link-belt machinery. Mr. J. A. Graham (No. Pac.) referred to the third form of plant described in the report, Fig. 3, and stated that it had given good satisfaction.

BUSINESS REPORTS.

Three short reports of a business nature were next presented. In the first of these on "The Advisability of This Association Joining the International Association for Testing Materials," the committee concluded that:

It would be better for this Association to adopt the specifications agreed upon by the International Council, if a majority of our members should indorse them, instead of becoming members, thus leaving it free to depart from them at any time a majority vote would favor doing so.

The convention voted to adopt the recommendation of the committee.

The second report was upon the "Establishment of a Joint Library in Connection with the Master Car Builders' Association." The committee thought such a library would be of little practical benefit to the members and advised that it should not be established. The recommendation of the committee was adopted by vote of the convention. The third report was on "The Index of the Proceedings." The committee reported that a complete index of the proceedings of the Association since its organization had been prepared and was now being delivered from the printers. By vote of the convention a resolution of thanks was offered to the committee for its work.

AN UP-TO-DATE ROUNDHOUSE.

The report of this committee is printed in abstract in another column of this issue.

DISCUSSION.—Mr. G. W. Rhodes (B. & M. R.) called particular attention to the two essentials of light and ventilation in roundhouses. It was, he thought, generallly conceded that a roundhouse should not have less than 80 ft. clearance inside, and with so great a dimension the problem of securing ample light at the center became a serious one. He questioned whether the arrangement of the windows shown by Fig. 2 of the committee's report was well adapted to light up the machinery of the engine. He also felt disposed to criticise the flat roof as being poorly adapted to give ventilation. On the whole, he considered that better ventilation and better light could be secured by using a steep roof.

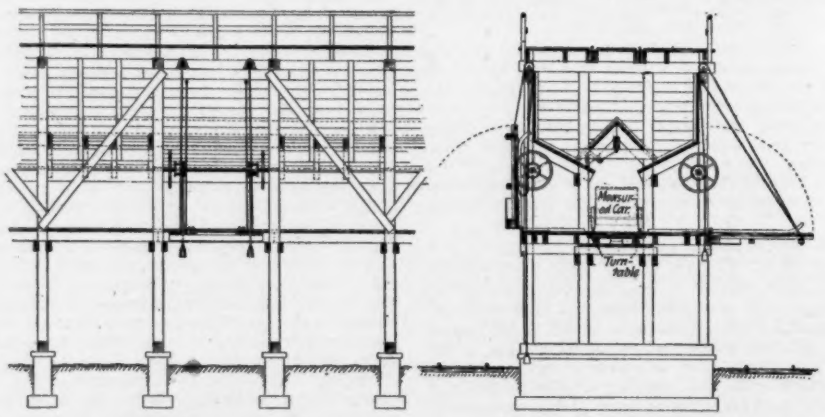
Mr. R. P. C. Sanderson referred to the design shown in Fig. 1 of the committee's report as having been developed under his direction. This house was quite light and was very perfectly ventilated. One advantage of the side windows was that they could be easily cleaned. In his judgment, the depth of pit given in the report was a little excessive. A shallower pit would save the use of staging and would facilitate drainage. With regard to artificial lighting, he had come to the conclusion that a circle of incandescent lamps, one each pit, was desirable to enable the men to get around the house. For lighting the machinery he favored a group of six 25-c.p. incandescent lights between each pair of pits. Each group of lights should be controlled by a separate switch. He favored telescopic smoke jacks of cast iron. He thought that a larger motor than the generally-adopted 10-HP. motor was desirable for operating turntables. In kindling fires he had found good results from building a hummock of coal in the center of the grate with a few chips and some old waste embedded in one side and setting the air jet directly opposite to blow the fire through the coal. The coal when ignited was easily spread over the grate. He had found that it was very difficult in a busy roundhouse to keep up a sufficient supply of hot water for boiler washing. If, however, the cold water were run into the boiler as the hot water ran out there was no difficulty in reducing the temperature so gradually that no injury resulted to the boiler.

Mr. W. H. V. Rosing (Ill. Cent.) dissented from the suggestion of the report respecting the disposal of the blow-off steam. He had a blow-off pipe from each pit connecting with a main pipe running around the house, and this main pipe discharged into a sump or reservoir about 30 × 25 × 30 ft., which held the wash and boiler feed water. In this way the water could be kept at 110°, which was as hot as could be handled by the men. For lighting the pits at night he used a 100-c.p. lamp between each pair of pits.

Mr. R. D. Smith (C., B. & Q.) pointed out that 18 ins., the thickness of pit wall shown by Fig. 3 of the report, was about as little as was desirable. He also thought that the provisions recommended for artificial lighting could not be considered excessive for an 80-ft. house. He questioned whether the electric motor for operating turntables was entitled to the preference given to it in the report. It was his belief that gasoline or steam motors were less expensive. He favored the use of wood for kindling fires. In 1895 comparative tests had been made at the Chicago roundhouse of the C., B. & Q. R. R., of the cost of oil and wood for kindling locomotive fires. The total cost of starting a fire with oil was found to be 38.74 cts., with oil costing 2.78 cts. per gallon and coal costing $1 per ton. The cost when using wood, exclusive of the cost of the wood, was 18.92 cts. The difference between 38.74 cts. and 18.92 cts., or 19.82 cts., showed the maximum allowable cost of wood per fire if it were to compete economically with oil. In other words, where wood could be secured at less than $3.17 per cord it was more economical than oil at 2.78 cts. per gallon. They used old ties for kindling, and by using a bulldozer they were able to unload, cut, split and stack old ties for kindling for 27½ cts. per cord. This sum plus the cost of loading and hauling was the cost of kindling.

Mr. C. H. Quereau (D. & R. G.) called attention to the smaller danger of damaging the side walls at night by overrunning if the engines were headed into the house. With reference to night lights, he recommended in addition to the electric drop lights between pits an extension electric lamp, which the machinist could carry into the working parts and attach in a convenient position for lighting the parts on which he was at work. He agreed with Mr. Smith that wood kindling was preferable to oil. It seemed to be the general opinion that hot boiler wash water was desirable, but he was not inclined to attach much importance to the advantages of heating. In a boiler carrying 165 lbs. of steam, the temperature of the boiler water was between 365° and 400°. The ordinary temperature of the water furnished to the roundhouse was perhaps 50°. This water could not be heated to more than 110° and be used by the men. In other words, it was practically impossible to add more than say 60° to the ordinary temperature of the water, while the theoretical addition should be some 200°. He doubted if the added 60° really made much difference so far as temperature strains on the boiler were concerned, particularly as it was possible to run in the cold water as the warm water ran out and thus reduce the temperature gradually. One point not mentioned in the report was the desirability of having a system for distributing and checking roundhouse work. This was very important. For example, he would outline a system used by him. When the roundhouse foreman reached the work in the morning he wrote out slips from the work book, putting one job on each slip. These slips he distributed to his men, who were thus told just what work to do and where it was located. As each man completed his task he signed the slip and returned it. On the roundhouse board there was a column for the call boy, another for the machinists, etc. Marks on these columns indicated that the crew had been called, that the machinists' work had been done, etc. Similar records showed that the boiler work was completed, the fire kindled, the steam on, etc. By this means the roundhouse foreman was relieved of the task of chasing the men up to find out if the engine was ready and could devote his time to more profitable employment.

Mr. A. L. Humphrey (Colo. & So'n) stated that having recently erected a 35-stall roundhouse he had endeavored to secure one as nearly satisfactory as possible. He provided first that the engines should head into the house. At the rear of the house he provided an outer conduit, into which all the water was drained. Between that and the back of the pit he provided a hot-air conduit. Between the 17th and 18th stalls he installed a hot-air heater and took from the stationary boilers steam to heat the coils. He installed a fan to force the hot air into the hot-air conduits, which opened into each pit toward the front. The air could be shut off from any of the pits by use of a slide valve. By this arrangement when in cold weather an engine came in covered with snow and ice, all the heat could be turned into the pit over which it stood and in a very few minutes the ice and snow were melted off. His preference was for wooden smoke jacks, protected by fireproof paint. For working around the engine incandescent lamps were used, so arranged that they could be extended into the pit and to any portion of the work-

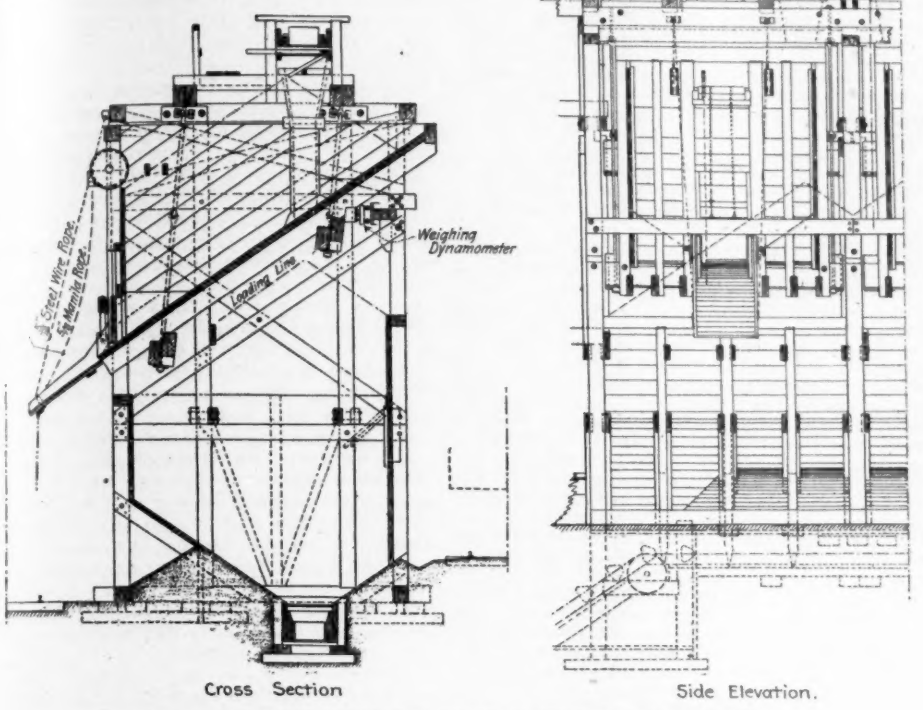


Longitudinal Section. Cross Section.

FIG. 2. COALING STATION ON ERIE R. R. AT SALAMANCA, N. Y.

ing parts. For lighting the benches and for general lighting arc lamps were used.

Mr. F. A. Delano (C., B. & Q.)called attention to the advantages of whitewashing the interior walls of roundhouses for securing better light. He was disposed to think favorably of lining the inside walls with white enameled brick. One great difficulty in using cold boiler wash water was that even if it were run in as the hot water was run out, it did not mingle with the warm water, but remained at the bottom of the boiler.



Cross Section Side Elevation.

FIG. 3. STANDARD COALING STATION, NORTHERN PACIFIC RY.

Mr. W. H. Marshall (L. S. & M. S.) called attention to the use of cast-iron chairs for carrying the rails on the pit walls. Regarding ventilation, the two worst ventilated houses he knew had peak roofs. In a roundhouse recently built, he had placed between each pair of pits three 32-c.p. incandescent lamps. He had found that an engine blowing off into a 5-in. pipe took 20 minutes longer to exhaust its pressure than if it blew off directly into the air.

The discussion closed with a vote to continue the committee and the subject for another year.

TOPICAL DISCUSSIONS.

The first topic taken up for discussion during the noon hour was "Material for Hub Liners on Cast-Steel Driving Wheels." The discussion was opened by Mr. D. F. Crawford, who stated his practice to be: to true up the hub, trim it to form a dovetail and cast the ordinary phosphos-bronze mixture on it, after which it was faced. Out of 35 engines fitted in this manner, none had given trouble. Mr. C. H. Quereau (D. & R. G.) used block tin. The mode of application was to countersink holes at intervals on the seat, drive soft brass pins into these holes and cast the tin around these pins. This attachment held the tin firmly. Mr. Wm. McIntosh (C. R. R. of N. J.) used and preferred babbitt. Mr. David Brown (D. & H. C. Co.) thought that cast-iron liners had proved on the whole as satisfactory as any.

The discussion of the second subject, "Maintenance and Lubrication of Piston-Rod Packing," was opened by Mr. D. Van Alstine, who said that inquiry had led him to believe that various troubles were being experienced with piston and valve-rod packing in high-pressure engines. This was due in his opinion to several causes. The most important of these was poor lubrication, and it seemed also to be the one most difficult to remedy. Feed cups were unsatisfactory, especially when a pipe had to be used to carry the oil to the swab, and swabs became glazed or were blown away from the rods by leaking steam. Something of a more adhesive nature than ordinary lubricating oil seemed desirable, and he had been experimenting with hard grease with some prospect of success, but could not say yet what the result would be. Mr. F. M. Whyte (N. Y. C. & H. R.) stated that experiments were being made to determine whether the lubrication of metallic packing is really necessary, and while the tests have not been completed, the indications seemed to be that lubrication was unnecessary. If lubrication was necessary the lubricant must be applied to the packing on the inside side, where the leaking steam would blow it onto the packing and not applied on the outside, where the leaking steam would blow it away. Mr. Charles Graham said he had tried metallic rod packing without lubrication, and had found the wear so great that he had been obliged to abandon the scheme. Mr. P. H. Peck (C. & W. I.) thought that if dirt were kept from the rods they would not need lubrication. He had used a sort of false gland packing to collect the dust with advantage. Mr. Wm. H. Lewis (Norf. & W'n) thought that if the cylinder were well lubricated the rod-packing would receive enough oil without any special provision for lubrication. Mr. J. L. Lawrence (Cumb. Val.) considered that if the proper metal were used for packing there would be no trouble. After several trials he had settled upon magnolin metal as the most satisfactory. Mr. Wm. McIntosh (C. R. R. of N. J.) thought that it would be advisable to use positive feed lubrication of some sort. This discussion closed the technical proceedings of the convention, which then proceeded to routine business.

ELECTION OF OFFICERS.

As the result of the several ballots, the following officers were elected to serve the Association for the ensuing year: President, A. M. Waitt (N. Y. C. & H. R.); First Vice-President, J. N. Barr (B. & O.); Second Vice-President, G. W. West (N. Y., O. & W.); Third Vice-President, F. A. Delano (C., B. & Q.); Treasurer, Angus Sinclair.

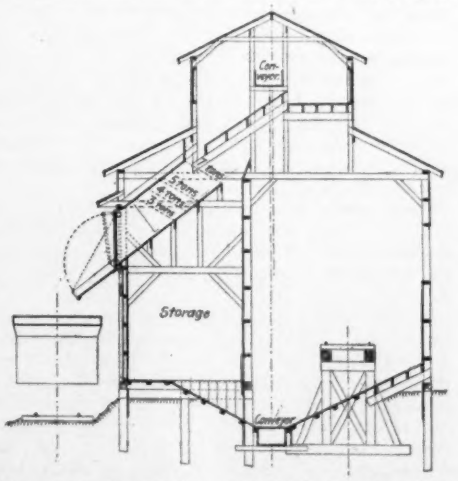


Fig. 4. Coaling Station at Jackson Junction, Mich.; Michigan Central R. R.

EXCURSION AND ENTERTAINMENTS.

On June 21 the members of the Association were tendered an excursion to the Schenectady Locomotive Works, Schenectady, N. Y., where luncheon was served and several hours spent in visiting the various departments of the plant. A variety of entertainments were provided during the convention by the committee of the Supply Men's Association, including concerts, a ball, minstrel show and carriage trips.

MECHANICAL FILTRATION AT ELMIRA, N. Y.*

By James M. Caird.†

The Chemung River is formed by the union of the Tioga and Cohoctan rivers, 19 miles above Elmira. The Tioga River rises in the coal district of Pennsylvania and has an average descent of 17 ft. per mile. The Cohoctan River has only a slight descent. The slope of the Chemung River from Painted Post to Elmira is at the rate of 5.9 ft. per mile; it then flows through the city of Elmira for three miles at the rate of 3.5 ft. per mile. The river is subject to severe floods; at times the water rises 18 ft. The area drained above Elmira by the Chemung River and its tributaries is about 2,050 square miles.

On examining the polluting territory of the river for a distance of 50 miles above Elmira, there will be found to be over 50,000 people in cities and villages and over 15,000 people having direct sewerage connections with the river. The water always has a marked turbidity and carries heavy suspended matter.

The water for filtration at Elmira is taken from the river through a crib, which is connected with a gallery; from thence it flows to two Worthington high-duty pumping engines of 6,000,000 and 10,000,000 gallons daily capacity. Only one of these pumps is used at any time.

The water is forced through a 20-in. main to the filter plant, which is about two miles north of the pumping station. The pumps lift the water 118 ft. for delivery.

The filter plant consists of 18 Jewell subsidence gravity mechanical filters, each having an effective filtering surface of 113 sq. ft. This makes a total of 2,034 sq. ft., or about ½ acre. The filters have been operated at the rate of 157,000,000 gallons per acre per day, thereby filtering over 7,500,000 gallons daily.

The water to be filtered is treated with a solution of sulphate of alumina, consisting of: Water, 43.1%; SO_3 (sulphuric acid), 38.4%; Al_2O_3 (available alumina), 17.5%; insoluble, 3%; Fe (oxide of iron), trace.

The alumina is dissolved in two tanks, having a capacity of 1,700 gallons each. From the dissolving tanks the solution is pumped to the distributing tank, which is at the top of the filter buildings; from this it flows by gravity to the supply main, entering it about 30 ft. outside of the filter building.

The amount of solution which leaves the distributing tank is governed by weir rings. The distributing tank is also equipped with a large overflow pipe, which discharges into the dissolving tank. The distributing tank is always overflowing. The overflow is used to keep the solution in the dissolving tank thoroughly mixed. The solution of sulphate of alumina is prepared by weight, the proportion being one part of alumina to 20 parts of water.

After treatment with the coagulant, the water passes to the subsidence basins, where it has about 30 minutes' subsidence. The water then passes to the top of the sand, and after passing through the sand it is discharged into a flume which conducts it to the filtered water or distributing reservoir. The latter is not covered.

The sand bed is about 48 ins. in depth. The sand used comes from Red Wing, Minn., and is almost pure silica, the grains being nearly uniform in size and shape. It has an effective size of 0.56 mm. and a uniformity coefficient of 1.43.

Use is made of the water in the flume (on its way to the distributing reservoir) to turn a water wheel, which operates two pumps; one of these pumps raw and the other filtered water through the observation tubes. The observation tubes are on the operating floor and consist of two glass tubes 4 ins. diameter and 5½ ft. long. If the removal of the turbidity is complete, the bacterial efficiency will be satisfactory.

Several bacteriological tests have been made at the filter plant since June, 1898. A test of the subsidence basin (60 samples being taken in seven days' operation) showed that it removed from 30.2% to 89.4% of the bacteria, the average being 69.8%.

The general efficiencies of the filters, by months, is shown by Table I.

TABLE I.—Bacterial Efficiencies of Mechanical Filters at Elmira, N. Y.

Date.	Bacteria per cu. cm. Influent.	Effluent.	Per cent. reduction.	Alum, grs. per gal.	Rate per acre per day.
June, 1898.	2,500	101	95.08	.45	99,000,000
July, 1898.	3,046	84	97.26	.53	91,300,000
Aug., 1898.	1,166	45	96.19	.51	97,800,000
Feb., 1899.	4,000	182	95.38	.47	66,200,000
Mar., 1899.	7,338	150	98.10	.96	83,000,000
Oct., 1899.	1,074	27	97.48	.81	94,300,000
Nov., 1899.	11,900	118	99.02	2.89	105,000,000
Mar., 1900.	35,580	79	99.82	3.16	73,000,000
Aug., 1900.	578	20	96.47	.72	94,000,000
Sept., 1900.	516	14	97.18	1.35	98,000,000
May, 1901.	1,848	23	98.43	1.38	107,000,000
Average..	6,322	76	97.31	1.20	91,600,000

Before March, 1899, the alumina solution was pumped directly into the main supply. This method proved to be very unsatisfactory, as the fluctuations were too large. With the new method of feeding, the coagulant is applied with great uniformity.

*Abstract of a paper read before the American Water-Works Association, at New York city, June 18.

†Of Troy, N. Y.; Chemist and Bacteriologist, Elmira Water Company's Filter Plant.

Disregarding the results obtained before March, 1899, we have, for the last seven entries in Table I., an average of 8,392 bacteria in the applied water, 60 in the effluent, giving a removal of 98.07%. For the same period an average of 1.61 grains of alum per gallon was used, and the rate of filtration was 93,470,000 gallons per acre per day. The results represent the efficiency of the filter plant in its present or perfected condition. There has never been any free alumina in the effluent, the alkilinity in flood time being sufficient to decompose five grains of coagulant to the gallon.

The bacillus coli communis has always been found in the river water. During a test made March, 1900, the influent was examined four times and the bacillus coli communis was found in all samples. The effluent was examined six times with negative results.

The general efficiency during this test follows:

Bacteria per cu. cm. Raw.	Filtrate.	Per cent. reduction.	Alum, grs. per gal.	Rate of filtration.
35,580	79	99.82	3¼	73,000,000

The bacteria are cultivated from three to five days at 20° C., the time varying with the seasons. The plating is so arranged that not more than 300 colonies are in a plate.

Beginning with the year 1895, a very careful record of the typhoid fever cases has been gathered under the direction of Dr. H. D. Wey, Health Officer. The population of Elmira is about 35,000; it is estimated that 20,000 use the filtered water, which leaves 15,000 having wells for their supply.

The total number of cases of typhoid fever in Elmira for three years before the filters were put in operation was 629; total number of cases during three years' operation of the filters was 284; this makes a reduction of over 60% in the total number of cases.

The cases by years and the water they used is shown by Table II.

TABLE II.—Typhoid Fever Cases at Elmira, N. Y., Before and Since Filtration.*

(Before Filters Were in Operation.)

Date.	Total cases.	Using city water.	Using well water.	Imported.
1895	107	21	27	59
1896	439	287	123	29
1897	83	43	32	8
Totals	629	351	182	96

(After Filters Were in Operation.)

Date.	Total cases.	Using city water.	Using well water.	Imported.
1898	76	38	35	3
1899	75	29	45	1
1900	97	42	47	8
Totals	248	109	127	12
Difference	381	242	55	84

From the above figures, it is seen that there has been a reduction of over 68% in the cases of typhoid fever among the users of filtered water. There has been a reduction of only 30% in the cases of typhoid fever among the users of well water. During the last three years there have been 109 cases of typhoid fever among the 20,000 users of filtered water; while during the same period there have been 127 cases of typhoid fever among the 15,000 users of well water. It would seem that the greater number of cases of typhoid fever was among the users of well water.

*It should be noted that these are cases, and not deaths. —Ed.

ANNUAL CONVENTION OF THE MASTER CAR BUILDERS' ASSOCIATION.

FIRST SESSION.

The 35th annual convention of the Association was held at Saratoga, N. Y., June 24, 25 and 26, the sessions being held in the Theatre Saratoga. The first session of the convention was opened by prayer by the Rev. Delos Jumpp, of Saratoga. A telegram of welcome was received from Governor Odell of New York, and was read by the secretary. President A. B. Knapp, of the village of Saratoga, welcomed the convention on behalf of the village, and President J. T. Chamberlain of the Association then read his address, reviewing the work of the various committees. The report of the Secretary showed the total membership of the Association to be 483. The total receipts during the year were $9,278.92, leaving a balance after all expenses were paid of $709.81. The Treasurer reported the total balance in the treasury of the Association to be $9,590.48. The dues for the ensuing year were made $4 per vote. Under the head of new business Mr. C. A. Schroyer (Chic. & No'w'n), called attention to the fact that the inspectors of the Interstate Commerce Commission were reporting the absence of a cotter pin from the knuckle pin of couplers as a defect. According to his understanding, the original intention and purpose of the cotter pin had been to prevent loss of the knuckle pin during shipment of couplers. He had never known of a knuckle pin being lost by working loose due to the absence of the cotter pin when cars were in operation, and he considered the cotter pin in no sense a necessary part of a coupler so far as the safety of that device in operation was concerned. Mr. W. H. Marshall (L. S. & M. S.) called attention to the fact that certain roads hauling coal to the great lakes where car dumping machines are used have found it desirable to retain the cotter pin to prevent the loss of the knuckle pin and knuckle when the car is turned over in dumping. Mr. J. N. Barr (B. &. O.) offered the following resolution:

It is the sense of the association that the cotter pin should not be considered a necessary safety device in connection with knuckle pins.

The resolution was adopted.

The convention next proceeded to the work of amending the rules of interchange, which occupied its time during the remainder of the session. For the most part the changes suggested were of minor importance and were voted upon and settled with little discussion. A proposition to increase the prices for air brake work, however, aroused protest, and a lively discussion followed. The proposition was that the prices should be changed as follows:

Triple valve cleaned and oiled, 20 cts. instead of 10 cts.
Cylinder cleaned and oiled, 25 cts. instead of 15 cts.
Retaining valve repaired, 20 cts. instead of 15 cts.

The items were considered separately. In advocating the increased price for triple valve cleaning Mr. C. H. Quereau (D. & R. G.), Mr. G. W. West (N. Y., Ont. & W.), Mr. Deems (C., B. & Q.), and others called attention to the fact that many railways were seriously neglecting the proper cleaning of triple valves. In many cases such valves had not been cleaned in years, and in more cases the cleaning was merely a perfunctory one, wholly inadequate to keep the valve in good condition. The chief reason for this was that the price allowed for cleaning triple valves was so low that the railways shirked the work whenever possible. Should the price be raised it would be an incentive for every road to clean its valves to avoid paying its neighbor a profit for doing it, and the neighbor would be incited to do the same work for the profit there was in it. The opposition to the increase was not strong and consisted mostly in making its advocates prove the justice of their claims. It was voted to make the price of cleaning, oiling and stenciling triple valves 20 cents, on the understanding that such work included removing the valves from the car, taking it apart, cleaning and oiling the parts, and, finally, testing the reassembled valve. The next motion to make the price of cleaning cylinders 25 cts. received more strenuous opposition, but the meeting adjourned before a decision was reached.

GAS, ELECTRICITY AND ACETYLENE COMPARED FOR LIGHT, HEATING AND POWER IN GERMANY.

In a recent issue of the "Journal für Gasbeleuchtung," Mr. M. F. Schafer assumes that a small town, wishing to establish a central station for the distribution of light and power, has to select between coal, gas, electric power and an acetylene plant, and he advises that coal gas be chosen, setting forth his reasons as follows:

In a gas installation, the receipts can be closely estimated. Experience in Germany shows that the company can count upon an average of 500 burners per 1,000 inhabitants, including public lighting; and upon one horse-power per 200 inhabitants consumed for power. This average represents a consumption of about 30 cu. m., or 1,059 cu. ft. per capita per year; of which 8 to 10 cu. m. are consumed for power. At the German price for gas, this figures out approximately to $4 per burner per year for light and heat; $30 to $32 per annual horse-power, and $2.50 for each gas-stove installed for cooking.

Cooking and heating by electric current are not yet sufficiently developed to be useful; electric motors are not as economical as gas-engines; and electric light is generally more costly than gas light.

In Germany a consumption of electric current amounting to 10 kilowatt-hours per head per year is very rarely met with, even in large cities; and the mean consumption for 1900 was 6.8 kilowatt-hours. To better illustrate, Mr. Schafer cites actual experience in the little town of Neuhaldensleben, in Saxony, with a population of 9,924 inhabitants. In 1892, this town established an electric plant; and after 6½ years of operation it had 142 subscribers with 157 meters, representing a total power of 272 kilowatts. This last was subdivided into 3,500 incandescent lamps, 38 arc lamps, and 9 motors, aggregating 23 HP. The average power consumed per inhabitant was thus 27.4 kilowatts; this is much higher than the consumption in the majority of larger cities, for it is only 25.37 in Frankfort-on-Main, 17.46 in Berlin 13.11 in Cologne and 9.15 in Dusseldorf.

In 1898, the energy distributed at Neuhaldensleben was 78,468 kilowatt-hours; of which 12,615 were for public lighting and 10,170 for motors, leaving 65,853 kilowatt-hours for private lighting, or 6.6 per head per year. The total consumption per head per year was 7.9 kilowatt-hours, about the same as for the cities of Hamburg, Munich, Leipzig, etc. The selling price was 15 cts. per kilowatt-hour for light, and 8 cts. for motive power; the gross receipts were about $8[illegible], or a little more than $68 per consumer per year.

Mr. Schafer then compares this with a little town of Buckeburg, in Schamburg-Lippe, which has a population of 6,000, and in 1894 built a gas plant. In the year 1899-1900, there were [illegible]39 subscribers with 355 meters, including 157 for gas engines. The number of burners was 3[illegible]4, and the 13 engines aggregated 45 HP.; and the author says that we should not forget in comparing the number of lamps, that a gas-burner with incandescent mantle, gives more light than an incandescent electric light. The consumption of gas in this town amounted to 195,098 cu. m.; of which 29,129 cu. m. were used for heating, and 17,[illegible]12 cu m. for motive power. The average consumption was 32.5 cu. m. per head per year. In admitting that one cubic meter of gas is equivalent to a little more than one kilowatt-hour of electric power, it will be seen that the private consumption in Buckeburg is exactly three times that of Neuhaldensleben, and the consumption per head per year is five times greater for Buckeburg.

Gas was sold at Buckeburg for 4½ cts. per cubic meter for light, and 3½ cts. for heat and power. The gross receipts of the plant were $8,315 per year, or about $28.75 per consumer per year, or a little more than half of that paid in Neuhaldensleben. The total receipts of Buckeburg, however, are nearly equal to that of the other town, owing to the sale of by-products, of tar, coke, etc. The gas plant also allowed the installation of numerous gas-cooking and heating stoves, a valuable source of revenue.

As to the use of acetylene, the author says that the light is relatively costly; it is practically impossible to utilize this gas in heating apparatus or in motors, for the cost of the material necessary to produce a cubic meter of acetylene gas is six times greater than the cost of a similar volume of coal-gas; while the calorific power of acetylene is only three times that of coal-gas. He thinks that acetylene gas is only advisable for isolated buildings, with no central lighting plant within reach.

A NICARAGUAN RAILWAY CONCESSION has been granted to H. C. Emery, of Chelsea, Mass., for a railway from Matagalpa to the head of navigation on the Rio Grande—about 100 miles of road. Mr. Emery must complete the railway within five years; but he is to receive a concession of public lands along the line, in alternate sections of 1 mile long and 4 miles deep. He has rights of navigation on the Rio Grande and Atlantic coast, and rights and exemptions for all colonists brought in for 25 years.

THE LARGEST DRY-DOCK in the United States has recently been completed by the Newport News Shipbuilding & Dry-Dock Co., at Newport News, Va., and the battleship "Illinois" will be docked in it as soon as the dredging at the entrance is completed. The dimensions of this dock, No. 2, and of the older dock, No. 1, are as follows:

	No. 1. Ft.	No. 2. Ft.
Extreme length	638.6	860.5
Length on bottom	573	804
Width on top	130	162
" " bottom	49	80
" of entrance at top	96.25	114
" " " " bottom	50	84
Depth of water over sill	24.5	30
Height of sill above bottom of dock	4.5	1.7

THE ROCK FOUNDATION OF THE WACHUSETT Dam has been uncovered in the deepest part of the valley, and the work of laying masonry in the dam is now actively in progress. A quarry has been opened on land belonging to the state, about 1¼ miles from the dam, and granite of an excellent quality is being taken out. A branch track has been constructed from the Central Massachusetts Railroad to the dam and quarry. A central power station, containing two compound condensing Corliss engines of 500 HP. each and two Rand air compressors have been erected. Pipes conduct the compressed air both to the dam and to the quarry. At the dam two cableways are in use, having clear spans of 1,150 ft., the cables being suspended from movable wooden towers. The foregoing is taken from the June Bulletin of the Boston Society of Civil Engineers.

A SYMPOSIUM ON WATER CONSUMPTION AND THE USE OF METERS.

One of several good features of the meeting of the American Water-Works Association in this city last week was a group of papers, and the ensuing discussion, on water waste and meters. Abstracts of both the papers and discussion are given below. It will be noticed that Mr. Herschel's paper presents some of the broader phases of the question, and also subjects to a further analysis the figures on the same topic included in the article by Mr. Geo. I. Bailey, M. Am. Soc. C. E., in our issue of April 18. Mr. Herschel also gives some new records of water consumption and waste, supplied by his son.

In the second paper, Mr. Rosamond relates some facts from the experiences of two water companies. In the third paper Mr. Hodgkins shows what valuable information a man may secure, if he will but study the vagaries of water consumption in his own household.

AN ATTEMPT TO PROVE THAT THRIFT IN THE OPERATION OF WATER-WORKS IS MORE ECONOMICAL THAN WASTE.

By Clemens Herschel, M. Am. Soc. C. E.*

The title chosen for this paper has been selected with due diffidence, inasmuch as experience, so far, has shown that not much more than an attempt in this line may be undertaken. For, is it not argued every day that waste is the proper, the politic, even the truly best basis for the conduct of public water supplies, and do not cities and private water companies, throughout the United States, fairly vie with each other in the head-long chase of "extending the water-works" to supply deficiencies caused by waste? Thus is waste enthroned as an established feature of water-works operation, and no serious thought is given to any other method of supplying deficiences of quantity, quality, or of pressure, than the one of bringing in still greater quantites to waste.

It often becomes, and will continue to be desirable to purify water, before it is delivered, but the enormous quantities wasted render such purification works very difficult to encompass.

The water originally delivered, now become sewage, is cast in huge volumes into the nearest water course—an entirely unlawful proceeding, be it noted, unless the receptacle be a tidal stream. It were well first to purify this sewage, and communities can always be compelled by law to purify it, but its enormous volume, mostly waste, renders such purification nigh impracticable.

So the sewage is allowed to pollute streams which should be the sources of city water supply, and thus natural bodies of water, fit to be the sources of such water supply for the same or for other cities, are made difficult to find, and thus water supply works are made many fold more expensive than need be,—all this, it will be observed, to the end that needless waste may continue.

It is the purpose of this paper to show how easily a reform might be effected. We want, instead of wasting, as ordinarily, 50, or often 60 or 70% of the water delivered, even up to 80 odd per cent., to have these percentages represent use, and their remainders represent waste, or do even better. We want water-works to waste no greater and a less percentage of the water they convey, than is wasted by gas works of the gas taken into gas pipes, this being from 12 to 20%. Or to do in the United States as is done by well-managed water-works in Europe, who have only some 10% of water unaccounted for.

The quantity of water wasted in cities can be divided into two principal parts, that wasted upstream, and down stream from the consumers' stop-cock. Against the first part there is no remedy, except the good work to be done by the parties in charge of the water-supply plant, and of this I will speak later. But against the second part, mostly wasted on the consumers' premises, no remedy yet tried yields satisfactory or lasting results that does not enlist the co-operation of the consumer; and there is but one such method, namely, to give the consumer a direct pecuniary interest in the prevention of waste. How is this to be accomplished? By the simple process of selling water to him by measure.

I have said that selling water for domestic uses by measure will enlist the co-operation of the consumer in the prevention of waste. It does this immediately, yet without need of argument or urging. The mere establishment of an instrument to keep a record of amounts drawn, and the presentation of quarterly bills based on such amounts, is all that is needed. The bills convey their own lesson, and it is not possible to convey such a lesson without such bills.

A water meter is nothing but an instrument by means of which the annual cost of all the water supplied to all the consumers may be fairly apportioned among them; may be divided so that each one shall pay a fair part of the total. Incidentally it reduces waste enormously, it makes every one take an interest in keeping at least his own premises in order as regards water waste, and it thus reduces in like proportions the total annual cost of the whole of the water supplied to the whole body of water consumers. And water meters are as much a part of a well designed and operated system of water-works, as gas meters are of gas works, or electric meters are of electric works, and they should be treated in their purchase and setting like any other necessary part of the water-works plant.

*2 Wall St., New York, N. Y.

TABLE I.—Twenty-four American Cities, Arranged in Order of Least Consumption per Consumer.

No.	City.	Consumers, when known, otherwise population.	Taps.	Taps metered, %.	Consumption per day. Per tap.	Per consumer.
1	Woonsocket, R. I.	32,000	2,347	91.01	398	29
2	Brockton, Mass.	35,000	5,275	81.51	221	32
3	Fall River, Mass.	104,500	6,943	94.25	548	36
4	Sioux City, Ia.	33,111	3,000	50.83	476	43
5	Quincy, Ill.	36,252	2,700	48.15	611	46
6	Racine, Wis.	29,102	4,916	24.41	279	47
7	Lexington, Ky.	26,369	1,500	99.47	833	47
8	Des Moines, Ia.	62,139	7,499	57.19	400	48
9	Malden, Mass.	33,664	6,426	45.67	265	50
10	Utica, N. Y.	56,383	7,064	96.80	425	53
11	Providence, R. I.	187,300	21,566	82.60	470	54
12	Topeka, Kan.	33,608	2,900	18.97	655	56
13	Lawrence, Mass.	57,200	5,926	74.01	541	56
14	Covington, Ky.	42,938	5,300	78.30	472	58
15	Manchester, N. H.	56,987	5,500	67.27	636	61
16	Dayton, O.	85,333	12,000	46.67	442	62
17	Kansas City, Mo.	163,752	13,000	40.60	?	62
18	Peoria, Ill.	56,100	6,058	6.90	578	62
19	Taunton, Mass.	26,100	4,502	40.69	360	62
20	Newton, Mass.	32,800	7,087	84.68	294	64
21	Lynn, Mass.	73,000	12,577	19.88	370	64
22	St. Paul, Minn.	125,000	17,093	28.15	488	67
23	Worcester, Mass.	113,000	13,292	94.31	596	70
24	Salem, Mass.	35,700	6,400	2.81	390?	70

What measure of consumption per consumer or per tap may we expect to attain by the use of consumers' meters? A flood of light has been thrown upon this question by the highly commendable efforts of our colleague, Mr. George I. Bailey, Supt. Bureau of Water, of Albany, N. Y., the results of which are printed in Engineering News of April 18, 1901. From the replies received from 137 cities of the United States, it appears that the average consumption in the United States is 137 gallons per consumer per day, but once let 50% or more of the taps be metered, and this will reduce on the average to 62 gallons. Table I. presents shining examples of those who use more than they waste.

Arranging the same number of cities in order of greatest percentage of taps metered, we get Table II.

It must be evident at a glance that every municipality whose water-works are so managed that it does not succeed in appearing in both of these tables, fails in some essential particular of very best management. Going further, the best managed are those (assuming, of course, correct returns), the sum of whose rank in these two tables is the least figure. Then making a table of this sort, we have the figures shown in Table III.

The next question that arises, is why some of the cities shown in one or the other of the first two tables, make such a poor showing, nevertheless, compared with the 14 economical champions. It may be instructive to reason a little upon the statistics of the 20 who have fallen by the wayside under the test that has been applied.

Bayonne is the home of the very large works of the Standard Oil Co. Three large works use 1,250,000 gallons, out of 1,500,000 gallons used by the ten principal manufacturing works in the city. This makes the consumption per tap, based on total consumption, the large figure of 1,024, and the consumption per consumer, 94. Without the above-named 1,250,000 gallons draft, these figures would be 607 and 56, respectively. Bayonne for some years has been buying water by the million gallons, and as a consequence at once learnt the lesson to sell by measure, likewise. In contrast to this, may be considered the case of the Metropolitan District of Massachusetts, selling water by a rating based on "population and valuation," and as a consequence having the several municipalities which compose it, vieing with each other which shall waste the most. It costs them nothing, directly, to do so, whence the temptation. So that these works, which were ultimately to have delivered possibly 75 gallons per inhabitant, are already using and wasting 115.5 before their completion, and are already being extended to cost $40,000,000, before the construction of the works originally designed as ample for future needs, has been completed. It is evident, that in this case also, the remedy is to sell by measure; by the Metropolitan District, to the municipalities, to begin with; upon which, the like sale by the municipalities to the consumers will surely follow; and the last report of the Metropolitan Water Commissioners gives some indications of this policy being about to be advocated or adopted.

Yonkers, N. Y., sells water to a portion of New York city, and contains also some large carpet and hat factories. Perhaps it is wasting from service pipes or street mains, or both. With 97.67% of taps metered, it should not consume 730 per tap and 81 per consumer, unless such drafts be explained as above.

Atlanta, Ga., may be troubled in the same way as Yonkers.

Atlantic City, N. J., probably wastes too much through service pipes. Some years ago, it had many small galvanized iron delivery mains, and in about a dozen years after they are laid, such pipes leak all over, not in a few places, and the leakage is of a kind that does not show on the surface; hence is not found unless sought for as will be described later; especially are such leaks not found when the pipes are laid in a sand-flat near the ocean, like the one on which Atlantic City is built.

TABLE II.—Twenty-four American Cities Arranged in Order of Greatest Percentage of Taps Metered.

No.	City.	Consumers, when known, otherwise population.	Taps.	Taps metered, %.	Consumption per day. Per tap.	Per consumer.
1	Bayonne, N. J.	32,722	3,000	100	1024	94
2	Lexington, Ky.	26,369	1,500	99.47	833	47
3	Yonkers, N. Y.	45,000	4,968	97.67	730	81
4	Utica, N. Y.	56,383	7,064	96.80	425	53
5	Worcester, Mass.	113,000	13,292	94.31	596	70
6	Fall River, Mass.	104,500	6,943	94.25	548	36
7	Atlanta, Ga.	65,000	9,275	91.64	587	84
8	Woonsocket, R. I.	32,000	2,347	91.01	398	29
9	Newton, Mass.	32,800	7,087	84.68	294	64
10	Providence, R. I.	187,300	21,566	82.60	470	54
11	Brockton, Mass.	35,000	5,275	81.51	221	32
12	Covington, Ky.	42,938	5,300	78.30	472	58
13	Atlantic City, N. J.	28,500	4,249	77.62	537	80
14	Pawtucket, R. I.	80,000	8,263	76.80	799	82
15	Lawrence, Mass.	57,200	5,926	74.01	541	56
16	Milwaukee, Wis.	300,000	41,485	67.59	578	80
17	Manchester, N. H.	56,987	5,500	67.27	636	61
18	Des Moines, Ia.	62,139	7,499	57.19	400	48
19	Lincoln, Neb.	25,000	3,550	56.34	564	80
20	Fitchburg, Mass.	25,000	4,437	54.70	676	120
21	Lowell, Mass.	94,000	10,634	52.53	752	85
22	Sioux City, Ia.	33,111	3,000	50.83	476	43
23	Toledo, O.	65,384	11,888	50.26	652	119
24	Quincy, Ill.	36,252	2,700	48.15	611	46

Pawtucket, R. I., has something the matter with it, or else it would nigh cut its consumption per tap in two, and rank with its neighbor Woonsocket.

Milwaukee is doing well, but needs still more house-meters, also a thorough search for service pipe and street main leaks.

Lincoln, Neb., is probably in the same class with Milwaukee.

Fitchburg, Mass., suffers from excessive pressure, and also guesses at the amount consumed, instead of measuring it.

Lowell, Mass., and Toledo, O., are probably parallels to Milwaukee, Wis.

Racine, Wis., Malden, Mass., Dayton, O., Kansas City, Mo., Peoria, Ill., Taunton, Mass., Lynn, Mass., St. Paul, Minn., and Salem, Mass., err only in the small number of meters used; which is the same thing, under present circumstances, as saying that they could do better still by using more house meters; and also by making a thorough search for service-pipe and street-main leaks. But their small consumption compared with that of Milwaukee, Wis., Lincoln, Neb., Fitchburg, Mass., Lowell, Mass., and Toledo, O., causes them to outclass these last-named cities. In one view of the case they deserve even commendation for accomplishing with comparatively few meters, what others only attain at the expense of a greater percentage of taps metered.

The characteristics of the average well-managed system of water-works in the United States are then, as it appears to-day, a consumption per tap of not over 400 gallons per day, and a consumption per consumer of less than 60. Even this amount is twice as much as Woonsocket, R. I., consumes and more than the consumption of 14 cities in the United States, including such cities as Providence, R. I., with nigh 200,000 inhabitants, and Fall River with over 100,000.

If any one should still argue that prevention of waste is inadvisable, because tending to uncleanliness or to disease, the answer is, that no such effects have anywhere followed a prevention of waste. On the contrary, the wasteful are the most uncleanly everywhere, and vice versa. These dreaded effects have not followed in Woonsocket and Fall River, in Utica or in Providence, for example. More than that, the slightest tendency in this direction of a scrimping of needed water, or of a repression of use, instead of waste, can always be overcome by a fixed or minimum rate for an ample domestic supply, with only the excess paid for by measure.

It has already been alluded to, that service pipes and street mains furnish another source of waste in cities. In my own present opinion, service pipes are the greatest sinners of the two. But differing from waste situated down stream from the stop cocks, hitherto spoken of, very little work has yet been done in remedying this kind

TABLE III.—The Best Managed Water-Works, as Found from Test of Least Consumption per Capita, and of Greatest Percentage of Taps Metered.

No.	City.	Sum of ranks in previous tables.	Taps metered, %.	Consumption per day. Per tap.	Per consumer.	Private Co. or public supply.
1	Woonsocket, R. I.	9	91.01	398	29	Public.
2	Fall River, Mass.	9	94.25	548	36	Public.
3	Lexington, Ky.	9	99.47	833	47	Co.
4	Brockton, Mass.	13	81.51	221	32	Public.
5	Utica, N. Y.	14	96.80	425	53	Co.
6	Providence, R. I.	21	82.60	470	54	Public.
7	Sioux City, Ia.	26	50.83	476	43	Public.
8	Des Moines, Ia.	26	57.19	400	48	Co.
9	Covington, Ky.	26	78.30	472	58	Public.
10	Lawrence, Mass.	28	74.01	541	56	"
11	Worcester, Mass.	28	94.31	596	70	"
12	Newton, Mass.	29	84.68	294	64	"
13	Quincy, Ill.	29	48.15	611	46	Co.
14	Manchester, N. H.	32	67.27	636	61	Public.

of waste, upstream, from the stop-cocks. This is a difficult undertaking, but easier to accomplish now than formerly, with the means now at hand. It will require the dividing up of the city into districts, with meters on the street mains so that measurements may be made of the consumption of the district after closing the stop-cocks within it, one after the other, and even after all of them shall have been closed. In this way those leaky service pipes and street mains whose leakage will not show on the street surface, may nevertheless be found.

There has been a measure of excuse for neglecting so largely, in times past, the prevention of water waste of both kinds. It consisted in the great cost or imperfect construction of house meters, and in the total absence of a meter for large street mains. But both classes of such meters can now be procured of a simplicity of construction, durability, and moderateness of cost leaving little to be desired. To pass to figures: House meters may now be procured, set, at from $11 to $12; for reading them, repairs and maintenance, add $1 to $1.25 per annum per meter. Street main or Venturi meters cost from $70 for 6-in. to $4,000 for 60-in. meters, with discounts from these prices. A recording register to go with such a meter costs about $425 net, for all sizes, but is in my opinion needless, for waste-water detection work; the best way being merely to pipe the meter tubes to the sidewalk, and then use a difference pressure gage worth about $40, which a man can carry under his arm, to do the work on a hundred or more Venturi meter tubes, one after the other, as their record may be needed. Unless in exceptional cases, with overworked street mains, and added to this the case of a great conflagration, such meter tubes need no bye-pass; nor do they need a vault.

Thus far, I have dealt mainly with generalities, but can illustrate by a concrete example. My son, Winslow H. Herschel, has lately made a preliminary report upon the works of a water company, which I am permitted to use, and some results of which will illustrate the class of work now needed in most American cities, the local lessons that may be discovered upon doing such work, and the kind of financial situation discoverable. A Venturi meter had been put in by the engineer of the water company on the force main, similar to what a gas-works manager would call his master meter, before this investigation commenced, and it was owing to the presence of this master meter that the work to be described could be at once undertaken.

It appeared that with an average population of 10,900, the consumption was 5,610,000 gallons, or 515 gallons per inhabitant per day, which, as we have seen, is excessive for the consumption of an average tap, not of a consumer, and is 17 times the amount consumed in a properly-managed city of average make up. The city had, however, some large power and manufacturing plants. One was found to consume over 1,000,000 per day (incidentally, to be getting it under a contract based on no such a consumption). The filter plant used for washing purposes, about 120,000 gallons per day. The metered manufacturing corporations, about 500,000 gallons. Taking these out of the total, left a consumption of 348 gallons per consumer, which is still the record, and tenfold the proper amount. Comparing day and night draft, the wastage was estimated as 313 gallons per day per inhabitant, or 90% of the total.

By means of street-crossing gates, the city could be divided into districts and the effect noted, of shutting off, at night, any one district. In this way the leakage at 2 a. m., in ten such districts was found to vary from 233 gallons per inhabitant per day up to 750 gallons, averaging 313 gallons, and in only one case much exceeding 400. This was in a district mostly inhabited by Italian laborers or their boarding bosses, and composed of the cheapest kind of houses fitted with the cheapest kind of plumbing, and this plumbing not kept in order at that; it being much cheaper, of course, on a flat rate, to let the water run. In fact this might be called a "wide-open" kind of a water-consuming district. In a neighboring community, this same leakage was 261 gallons per inhabitant per day.

Inspection of houses soon showed that there was reason for supposing a waste in houses of at least 1,640,000 gallons per day. Several experiments made by increasing the pressure on the delivery main also showed clearly that there must be many holes open, for the amount wasted at night increased, by an increase of pressure, in such proportions as to clearly show the action of such discharge holes, and it was evident from the other experiments that these holes were pretty uniformly distributed over the whole city.

There were still 1,300,000 gallons to be accounted for, and to the best now attainable knowledge, this is due to the very poor kind of taps and service pipes in use, not to any one or a few great leaks out of the mains at a certain point or points. By putting in three Venturi meter tubes, at a cost of $600, the city could be thoroughly examined for leakage of service pipes and street mains as often as might de desired in the future, and thus do away with and keep away that source of leakage. One manufacturing concern was caught stealing water. He didn't know there had been anybody around at 2 a. m. metering, and bitterly complained the next morning of the interference with his work. District Venturi meters would readily discover cases of this sort. This city has only 1.5% of its taps metered, and this man had been drawing a large amount of water under a flat rate, day and night, for purposes other than those covered by his rate.

Assuming an increase in population of 50% every ten years, and supplying new consumers from waste converted into water available for use, the situation at the end of the several ten-year periods, up to the time when Fall River conditions of use and waste shall have been attained, would be as shown in Table IV.

TABLE IV.—Showing Improvement in the Financial Condition of a Water-Works Company, if Water now Wasted were to be Saved by Putting in House Meters, and Sold to New Consumers, as Fast as the Increasing Population Demanded it.

Year.	Population in 1900.*	No. taps to be metered. Present.	No. taps to be metered. Future.	Waste saved million gals. per day	Gross receipts per annum. Loss.	Gain.	Net gain.
1910	14,700	82	817	0.17	$2,755	$5,387	$2,632
1920	22,000	204	2,034	0.43	6,854	13,403	6,549
1930	33,000	388	3,868	0.81	13,068	25,492	12,455
1940	49,500	663	6,618	1.39	22,277	43,559	21,282
1950	74,200	1,075	10,735	2.25	36,120	70,627	34,507
1959	107,000	1,640	16,400	3.44	55,104	107,748	52,644

*On a basis of 9,800 unmetered consumers.

Besides this gain there could be had the additional gain consequent on a removal of whatever percentage of waste due to service-pipe and street-main leaks is to-day still in existence at Fall River. This ought not to cost as much per million gallons of water recovered, as the water obtained from waste on the consumers' premises.

It will be noticed that at no time is there a loss of revenue due to the cost of metering, or the removal of waste. In this instance, therefore, thrift has been shown to cost less than waste at all times. I maintain that the same proposition holds good to a greater or less degree, and if not for 59 years, then for 10, 20 or 30 years, everywhere; and to all cities in the United States, except possibly Woonsocket, R. I., Fall River, Mass., and Lexington, Ky.

THE RESTRICTIVE FEATURES TO GUARD AGAINST WASTE WATER.

By S. J. Rosamond.†

The twin city of Texarkana, Arkansas and Texas draws its water supply from a system of shallow wells. The daily consumption amounted to about 1,200,000 gallons, when the plant passed into the hands of the present manager. At times during the afternoon, the wells would not supply sufficient water to maintain the pressure. After becoming familiar with the conditions there, the management found that it was absolutely necessary to stop the waste of water, as the supply had about reached its limit. The company commenced the placing of meters on its consumers, and at the present time have about 500 meters on its 800 consumers, although the capacity of the wells has not been increased, neither has the pumping capacity been increased, yet the city has grown very much larger and the company's business has grown in proportion.

Undoubtedly the meter is the proper method of stopping the waste of water where it can be used, but all water companies are not so fortunate as to have a clause in their franchise permitting them to place meters on their services.

In 1896 when I was placed in charge of the water-works at Fort Smith, Ark., I found the consumption was 155 gallons of water per capita, and I began looking into the franchise with a view of placing meters on the services and met with the following clause:

> Rates for all persons not heretofore enumerated will be fixed by estimate or meter measurement, at a rate pro rata to quantity used, not exceeding in any instance 25 cts. per 1,000 gallons; and it is further provided that any party may use a meter for the measurement of their water consumed, and that the party requiring the meter must pay the cost of the same.

Unquestionably, where the meter can be used it will effectually solve the question before us, but there is another remedy that can be applied that is almost as effective as meters, namely, the requirement of first-class self-closing plumbing fixtures. By first-class self-closing plumbing fixtures I mean fixtures that close with the pressure and not against the pressure. There is a great variety of so-called self-closing fixtures made that are self-closing at a certain pressure. I refer to the cocks that, by the aid of a spring, close against the pressure. These are nothing more or less than safety valves that will close against the pressure a little above domestic pressure, and invariably, when fire pressure is put on the system, and just when it is necessary to the city's interest as well as the company's that the system be free from leaks, these so-called self-closing fixtures fly open and run a full stream during the period the fire pressure is kept on, whereas, with self-closing fixtures, that close with the pressure, even though there might be a slight leak before the pressure is put on, the increase in the pressure closes the valve tighter and in many cases entirely stops the leak during the period the fire pressure is on.

Below is given a rule which has been adopted and rigidly enforced by the company which I represent, at all of its plants.

†Superintendent Municipal Water-Works Co., Fort Smith, Ark.

> All faucets placed over hand basins or sink[s] with all urinal and water closets, wherever sit[uated] be operated with self-closing valves that "clo[se] pressure," except over bath tubs and stationary dry trays, where compression work may be use[d].

I have recently had occasion to time a leak the quantity of water that passed through th[e] 30 days. The amount of water as shown by that was delivered to the consumer was 32,0[00] This leak was very small, in fact so small th[at] consumer could not be made to believe that a[ny] considerable quantity of water was being wasted. tested and timed and found that 20 cu. ft. of hour was being wasted through this leak. small, but when multiplied by 24 hours to a d[ay] days per month, it showed a wastage of 32,[000] of water in 30 days. This water was wasting defective compression fixture, and amounted a[t] charged to $8. Let me add that previous to meter on this service we were receiving a flat per year for the service.

In discussing the placing of meters in tenement houses recently with a rental agent, he stated that he had no objections to paying for water through a meter at that when the service was metered for our protection we would take out all compression fixtures and replace them with self-closing fixtures for his protection.

As stated, the plant at Fort Smith passed into the hands of the present management in 1896, and notwithstanding the fact that the city has increased in population and 300 consumers have been added to the company's business, and a corresponding increase in the company's revenue, yet our pumping report shows that we pumped 11,489,680 gallons of water less during the month of April, 1901, than we did the corresponding month in 1896.

We have used both the meter and self-closing fixtures to reduce the waste and have given each method an equal credit.

SOME OBSERVATIONS ON THE HOUSEHOLD CONSUMPTION OF WATER.

By Henry C. Hodgkins, C. E.*

Some years ago, being quite closely confined to my house, I commenced to preserve the readings of my water meter. At first, I had no well-defined purpose, except to insure the perfect closure of the fixtures, and to compare the readings of two meters of different type. These readings, taken at varying intervals, have been preserved until the present time, and under such a variety of conditions that they may prove to be of interest to the Association.

To thoroughly understand what is to follow a description of the service is necessary. The lot is 66 ft. front by 264 ft. deep. The house is a 12-room house and sets back from the street about 66 ft. It is about 200 ft. from the street to the barn, and all the space in front of the barn, except that occupied by the house, walks, and drive, is a well-kept lawn. The barn is supplied through a separate meter. At the time the meter readings commenced the fixtures were: Hot and cold water faucets in the kitchen; hot and cold water to bath tub and lavatory; and one cascade water closet on the lower floor. On the upper floor hot and cold water faucets, and one cascade water closet. On the upper floor there was a large copper-lined tank, filled with rain water from the roof. All the fixtures were supplied from this tank except the cold-water faucet in the kitchen and the water closets. There was also a cistern pump from which laundry water was obtained; and also a lawn sprinkler connected to the service before it reached the house.

The family, including servants, has numbered six nearly all the time.

When the meters were first connected there was a pan closet on the upper floor. The amount of water running to waste through this closet was found to be so large that it was replaced at once with a cascade closet. The readings do not commence until this closet was in use.

The water pressure is about 90 lbs. A pressure regulator was placed in the service and then two meters of different manufacture were placed tandem.

No changes were made in the service until the spring of 1898, and during this time all faucets were kept absolutely tight, so that there was no waste, except through carelessness, or when the water was purposely allowed to run. A great deal of difficulty was experienced in keeping the float valves in the closet tanks, so that they would shut off the water when the tank was full. In fact so great was the difficulty in keeping these valves in proper order, added to the fact that a considerable waste can occur without any evidence, by sound or sight, of its existence, that I am forced to the conviction that tank closets are the most wasteful of all household fixtures. From the readings taken when I was satisfied that these valves would close tight, the consumption of water was about 7 cu. ft. per day. When the consumption is very greatly in excess of this amount, before the time when the water for lawn sprinkling was passed through the meter, it indicates trouble with the closet valves.

In the spring of 1898 the lawn sprinkler was taken out and thereafter all the water for lawn sprinkling passed through the meter. About this time the pressure regulator seemed to have given out and more trouble was ex-

*Syracuse, N. Y.

per[illegible] with the closet valves. During the summer while the family were away the valves were so bad, that for [illegible]me the water was shut off entirely. After numerous attempts to repair them, they were finally replaced with new ones, and in November, 1898, the readings again showed the legitimate consumption.

The readings during 1898 were chiefly valuable in showing the waste that occurred through closet tanks, when they were frequently pronounced by the plumber to be in perfect condition, and when there was nothing to the ordinary observer, except the meter readings, to indicate the contrary.

The meter readings showed that the waste during much of this time was as great as the proper consumption. From Nov. 24, 1898, to Feb. 25, 1899, the readings indicated no waste. On Feb. 25, the rain-water tank was disconnected, as the copper lining had failed so completely that repairs seemed inadvisable. The life of these tanks may be of interest. The tank in question held about 1,500 gallons. The first lining after being in use between 9 and 10 years failed completely by pitting. The second lining was in use six years, and failed at the edges between the sides and the bottom. After the tank was disconnected, the soft-water pipes were connected to the city water pipes, but the pressure proved too great, and the water was shut off from them, so that the conditions of consumption were not materially different until the new plumbing was installed.

After the large tank failed it was taken out, and the space, added to the room of the adjoining water closet, was utilized for a bath room.

When this bath room was constructed all the water pipes in the house, excepting short pieces behind the lavatory and kitchen sink, were replaced with new pipe. The main-service pipe runs to a tank in the attic, and off from this pipe is taken the cold-water faucet in the kitchen, one faucet in the upper bath room, the sill cock, and one faucet in the cellar. All other fixtures are supplied from the attic tank.

The fixtures as they now exist are as follows: Bath tub, lavatory, and water closet in upper bath room; bath tub, lavatory, and water closet in lower bath room; hot and cold water faucet in the kitchen, one faucet in the cellar, and sill cock for lawn sprinkling. Both hot and cold water are supplied to each bath and lavatory.

The pipe supplying water to the attic tank is provided with a float valve. The plumbing contract included a three years' guarantee for this float valve, and required all faucets and valves to be repacked and made tight. Notwithstanding this guarantee, before the plumbers were out of the house, the new float valve failed to work and allowed the water to run more rapidly than the small overflow then provided could take care of it, so that the tank overflowed, wetting things down pretty thoroughly. After the job was completed it required close observation and many visits of the plumber before a valve was provided that would absolutely close.

The rough plumbing was finished April 2, 1899, and the normal use of water was resumed. The city water was used from this date for all purposes except the laundry. The readings immediately increased to just about twice the legitimate consumption prior to this date. It is to be regretted that the times of making repairs and changes in the float valve were not recorded.

I estimate the quantity of water used for lawn sprinkling for the season of 1900 to be 4,015 cu. ft. This at 14 cts. per 100 cu. ft., the price charged by the Syracuse water department, amounts to $5.62. The schedule rate is $6. There was 8,000 sq. ft. of lawn kept in first-class condition.

The year's consumption, in addition to the water used for lawn sprinkling, is 5,333 cu. ft., amounting to $7.46, while by the schedule rates the amount would be $15.

From careful observations I would distribute the consumption to the several uses in the following proportions:

Culinary and drinking	15%
Laundry	10%
Water closets	30%
Bathing	45%

As the laundry water is taken from the kitchen faucets, this proportion, on the basis of $15 total charge, make the schedule of charges as follows:

Kitchen faucets	$3.75
Water closets	4.50
Bath tubs and lavatories	6.75

The Syracuse schedule is:

Kitchen faucets	$5.00
Water closets	6.00
Bath tubs	4.00

My observations lead me to fully indorse the large proportionate charge for water closets.

To recapitulate: When the water was used from only the kitchen faucets, and for the closets the consumption amounted to about 7 cu. ft. per day, or from 8 to 10 gallons per capita per day. From October 1, 1899, to April 30, 1900, the water being used for all purposes except laundry, the average consumption was 15½ cu. ft. per day, or per capita 19⅓ gallons per day. From Nov. 4, 1900, to March 31, 1901, when water was used for all purposes, including laundry, the consumption averaged 21¼ gallons per capita per day. During the summer months the maximum consumption, including lawn sprinkling, was 88 6-10 gallons per capita per day.

The average daily consumption from June 5 to July 8, 1900, was 76 gallons per capita; or for the lawn alone an average daily consumption of 455 gallons. As this was an extremely dry period it is safe to say that this is the maximum consumption for the premises described.

The quantity of water used for sprinkling varies greatly with the season and the party who uses the water. I consider the amount used during the summer of 1900 as ample for a very dry season and for 8,000 sq. ft. of lawn located in the latitude of Syracuse, unless the soil is of a very sandy nature, when more would be required.

DISCUSSION.

These three papers were a fruitful source of discussion. All agreed that meters will check waste and where universally used, will proportion the cost of service between consumers. Two or three questioned where the line is to be drawn between waste and use.

Mr. Geo. I. Bailey, M. Am. Soc. C. E., asked what could be done to overcome the prejudice that exists against the extension of the meter system. At Albany the two chief factors to contend with are the landlords and what may be termed political ease, or a lack of official backbone (outside the water department.—Ed.) when an attempt to introduce meters results in popular and political opposition.

Mr. Chas. E. Bolling gave some particulars of the notable results obtained with the expenditure of only $25,000 for meters at Richmond, Va. Since 1897 the consumption has been reduced from 167 to 100 gallons per capita and the pressure greatly increased. The meters were placed on the lower levels first, where the pressure, and therefore much of the waste, is greatest. The people have learned that they can, for instance, add a bath tub, under the meter system and the $8 minimum rate, without any increase in their yearly bill, whereas under the flat or fixture-rate plan every additional fixture means an increased charge. Mr. C. H. Campbell said that meters had cut down the consumption at Charlotte, N. C., by one-third. Mr. Clemens Herschel, M. Am. Soc. C. E., referred to a city which has a very low water consumption because it started in with meters on every service when the works were built.

Mr. Emil Kuichling, M. Am. Soc. C. E., asked the opinion of those present on the legitimate allowance for continuous running water in winter to prevent the freezing of house plumbing. The actual cost of the water involved was about one-fourth the amount of the plumber's bills in case of freezing. As a measure of broad public economy is it not cheaper to pump the necessary extra amount of water than to burn coal in the attempt to so heat the houses as to prevent freezing, and to pay plumber's bills where the attempt fails? These questions, very likely, were intended to elicit discussion, rather than as expressions of Mr. Kuichling's own opinion. In any event, they prompted many strong expressions of opinion, all of which were vigorous protests against such heretical doctrines. Mr. Wm. R. Hill, M. Am. Soc. C. E., thought it a mistake to let the idea get abroad that it is necessary to waste water to prevent freezing. Service pipes should be placed so deep and plumbing so protected as to preclude danger from frost. In Syracuse there were, in a single year, 5,000 metered consumers who did not use over 3,600 cu. ft. a year. None of these could have let their faucets run to prevent freezing. Mr. Bolling said that before meters were installed at Richmond a fall of temperature to 20° F. would be accompanied by a reduction of pressure from 17½ to 0 lbs., in one section of the city. Since meters have been in use, there has been no such experience. If people with meters let water run to protect their plumbing in cold weather, they take care to see that the stream is a small one. Mr. Rosamond did not believe in calling on water companies to save individual plumbing bills. One cold night at Fort Smith, Ark., a hotel was burned down. The pressure was very low and the water company was bitterly attacked because of that fact, but public opinion changed when it was made known that an assistant chief of the fire department had every faucet in his house open that night—to save plumbers' bills. Since then the company has made night inspections. An aquaphone is used to detect running water and if it is found that water is being wasted all night, that particular service is shut off immediately. Mr. Rosamond explained, later on, that the water company co-operates with the consumer to detect and prevent waste, instead of always being so summary as the foregoing might indicate.

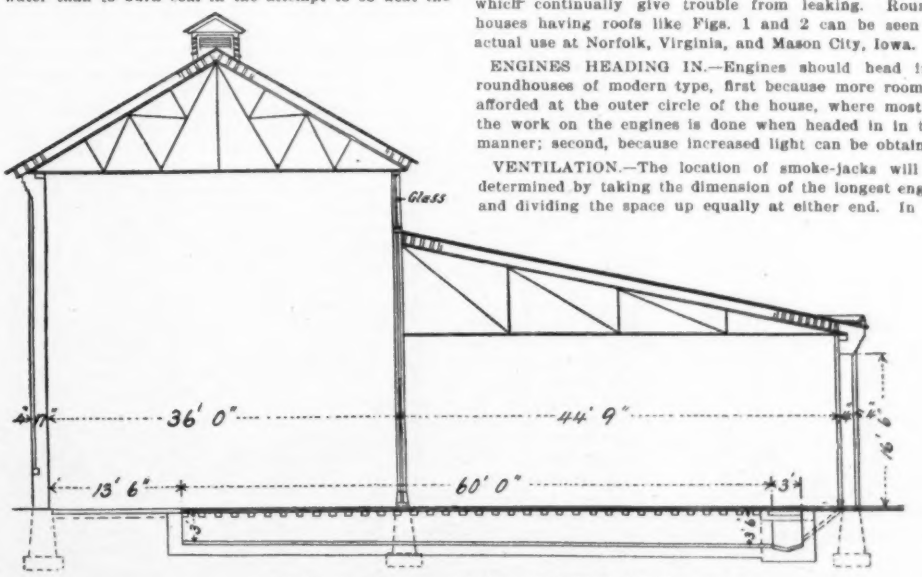


FIG. 1. STEEL FRAME ROUNDHOUSE.

THE CONSTRUCTION AND EQUIPMENT OF A MODERN ROUNDHOUSE.*

A circular of inquiry containing 40 leading questions on the above subject was sent out to every member of the Association, and the following report was prepared after each member of the committee had carefully considered the responses.

As the appurtenances of the house depend entirely upon the general dimensions, your committee has concluded that the length of the roundhouse should not be less than 80 ft. in the clear. Rapid strides have been made in the design and construction of locomotives during the last few years, and it is not infrequent for us now to find a number of engines that measure from 65 to 70 ft. over all. A locomotive 70 ft. in length would only give us 10 ft. in clearance. This being divided equally would only leave 5 ft. between each wall.

Doors should have a minimum height and maximum width of 16 ft. and 12 ft. in the clear, respectively. The upper portion of the doors should have as much light in as can be obtained without interfering with the strength of same. The window space should be as ample as considered consistent with the strength of the walls in the outer circle of roundhouse.

LIGHT.—In building roundhouses of the minimum length of 80 ft., it will at once be seen that the light from the outer and inner circle of roundhouse will be insufficient, particularly in the short days of the autumn and winter, and as more light is desirable about the center of the house, it will at once be apparent that we must arrange for additional light. This can be done as shown in Figs. 1 and 2, without necessitating skylights which continually give trouble from leaking. Roundhouses having roofs like Figs. 1 and 2 can be seen in actual use at Norfolk, Virginia, and Mason City, Iowa.

ENGINES HEADING IN.—Engines should head into roundhouses of modern type, first because more room is afforded at the outer circle of the house, where most of the work on the engines is done when headed in in this manner; second, because increased light can be obtained.

VENTILATION.—The location of smoke-jacks will be determined by taking the dimension of the longest engine and dividing the space up equally at either end. In the North, on account of the cold weather, it is necessary to use smoke-jacks. In the South, continuous ventilators, as shown in Fig. 1, give good results.

Your committee would recommend that ventilators be used at least in every other stall, with a minimum dimension of 3 × 4 ft., and not less than 2 ft. in height, and these to have the usual slats in the sides. In the North we recommend that a damper or drop-door be placed in the bottom of each ventilator so that they can be closed up in winter time when necessary. In the South it is not considered necessary to have these additional openings where they have a continuous ventilator at the highest point of the roof, which is used instead of smoke-jacks, as shown in Fig. 1.

PITS.—The length of pit should be 60 ft.; the depth of same to be governed by the type of power used on the line for which the roundhouse is being built. For example: If engines have large fire-boxes, and the wheels

*Abstract of a report presented to the American Railway Master Mechanics' Association at Saratoga, N. Y., June 18 to 20, 1901, by a committee consisting of Robert Quayle, Chairman; D. Van Alstine and V. B. Lang.

are from 63 ins. and upwards over all, we recommend that the pits be 2 ft. 6 ins. minimum depth, and 3 ft. maximum depth. If the wheels of the locomotive are low, and most of them deep fireboxes, we would recommend that the pits be 3 ft. minimum and 3 ft. 6 ins. maximum depth.

RAIL ON PIT WALLS.—Two methods of supporting the rail on top of the pit walls are in vogue; one consisting of placing short ties extending to the edge of the pit wall and about 2 ft. long, the space in between them being filled with concrete, which helps to support the rail in case the tie should soften under the action of wash water, etc. The other method consists in surmounting the pit wall with a timber about 12 ins. square, upon which the rail is spiked. This construction, however, is much more expensive than the former, and apt to deteriorate more rapidly. In either case provision should be made for

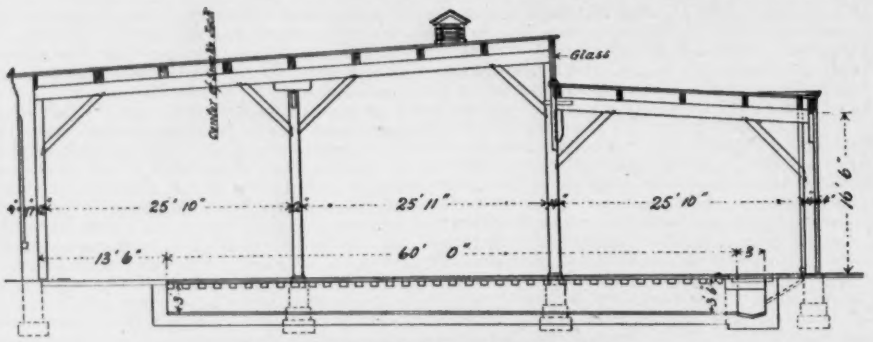


FIG. 2. TIMBER FRAME ROUNDHOUSE.

raising the engines by jacks. In the first arrangement of pit this is provided by placing a 4 × 12-in. timber on top of the ties just outside of the rail, whereas in the latter construction a timber sometimes 12 × 16 ins. is placed on edge immediately next to the rail sill, which gives ample strength for the base of the jacks, this timber being supported by piers or pilasters from the main pit wall. In either case pit walls should be designed to form proper support for the jacking timbers. It is quite important that the sills which support the rail be kept as dry as possible, and as water will accumulate between the floor and outside of rail, it is preferable to have this filled in either with wooden strip or cement, or if this is not done, to provide proper drainage under the base of the rail so that water running into the groove can continue down into the pit. This can be done by means of cross-notches underneath the base of rail about every 3 ft., as shown in Fig. 3.

PIT FLOOR.—The floor of the pits under the engines should be formed to a convex surface, the center being about 3 ins. higher than the sides, which allows workmen to work on dry floor, even if there should be some water trickling through the sides of the pit. The floor of the pit is best made of brick on edge on a concrete bed. If this is considered too expensive, it can be made of crushed stone and sand.

PIT DRAINAGE.—The drainage of the pit is a very important feature. The old-time method of having pipes and gates was a continual source of annoyance, as these pipes would continually choke up with waste and other refuse. Many modern houses have the engine pits extend to an annular pit, which is just inside of the main doors, this pit being made lower then the engine pits. This annular pit should be drained at some suitable point into the turntable pit or system of drainage. This pit should be deeper in the center than at the sides. It offers an opportunity where this is desired, for placing water and steam pipes. This pit should have loose covers which can be removed when necessary to clean out the pit, but ordinarily form a close door. The turntable pit should have a tile drainage to the main sewer. It should also be either paved with vitrified brick or cemented.

ROUNDHOUSE FLOOR.—An up-to-date roundhouse floor should be of vitrified brick laid on edge in a bed of sand. The consensus of opinion is that the brick floor is the best, and your committee would recommend a concerte bottom and then a layer of sand in which to bed the vitrified brick. When brick is laid, the floor should be covered with a layer of sand or tar (tar preferably) to fill in the joints.

WATER AND OTHER PIPES.—We also recommend that the water and blow-off pipes be placed in the annular pit, all other pipes to be placed overhead, with drop-pipes between every other pit, with suitable hose connections to connect with the locomotives. The blow-off pipe from the top of the dome to be connected with short pipes through the roof over each pit, connection with the engine to be made with flexible metallic joints.

We would recommend that the stationary boilers which are used for steam heat, pumping, machinery, etc., carry 125 lbs. steam pressure, and that the steam be conducted through the house in pipes not under 1½ ins.

It is recommended that compressed air be supplied at 100 lbs. pressure, as this is the most suitable for general uses, such as pneumatic hammers, air-jacks, rolling flues, etc.

HEATING AND LIGHTING.—The most modern method of heating at present seems to be by hot air and forced blast. The air can be taken from the roundhouse and warmed over and over again, thus reducing the cost of heating the air. While this air is generally carried in overhead ducts, your committee considers it should be investigated and determined in each case whether an underground duct would not be suitable. It is also suggested that air be taken from the boiler room, thus serving the double purpose of cooling this room and using the heat imparted to warm the roundhouse.

One arc light should be located over the center of the turntable, and not less than three 16-c. p. incandescent lamps should be placed between the pits; one about opposite the cylinders, another about opposite the cab, and the third about the center of the tank. There should also be located in convenient places in every other stall two connections for portable lamps for pit work and firebox work; all lamps to be covered with wire guards for protection.

SMOKE-JACKS.—Your committee is unable to satisfy itself on a roundhouse smoke-jack that would meet with general approval, but we are agreed that the smoke-jack should be made telescopic to fit the stack. It should also have a certain amount of swing parallel with the track, so as to provide against the same being pulled down should the engine move with the jack resting upon the engine stack. The smoke-jack should be provided with a damper, so that when the engine is put into the house and no fire on the grates, it will prevent the cold air from passing up through the flues. We also are of the opinion that a lever ought to be used to raise and lower the jack instead of the cable and sheaves which are commonly used.

DROP-PIT.—Every modern roundhouse should be provided with a drop-pit for removing driving wheels, extending across two tracks; also one closer to the outer wall of the house for removing truck wheels. These pits should be so arranged that the wheels can be removed from an engine on one track and run over to the adjacent track, and then lifted up to the floor. Jacks are preferably worked by power, air and water being the chief sources. The hydraulic power, however, has the advantage in that there is not the same elasticity and vibration that is noticeable when air is used.

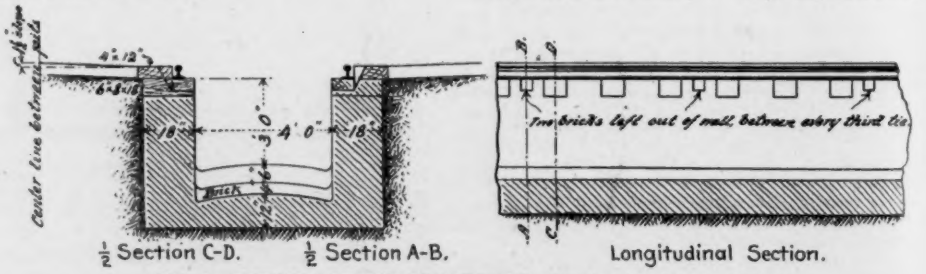


FIG. 3. DETAILS OF PIT CONSTRUCTION FOR ROUNDHOUSES.

TURNTABLE.—In the answers received a large majority favor structural steel turntables, designed so that all parts can be easily accessible, and frequently painted. When new tables are being put in, your committee would recommend that they be made at least 70 ft. long and be well braced. Experience shows that the long table with a load on it is more easily handled than the shorter table with the same load. This is no doubt due to the fact that you are better able to balance the engine by having longer leverage. It also avoids the crossing frogs on radial tracks. The center should be supported on conical steel bearings, and have latches at both ends of the table. These should be a decking forming a footbridge on each side of the rails. This decking should be no less than 15 ft. wide over all. Your committee recommends electric power for operating turntables in preference to any other in use. If, however, there is no electrical power available, the gasoline engine can be used for this purpose very successfully. If the electric motor be used a foot-brake is very desirable, as it will save trouble with the motor by the operator reversing the current in order to stop the table at the proper place. Such a brake will also allow the omission of the lock, as the table can be held securely by this means when the engine is moving on or off.

TOOLS.—Your committee recommends as many wall benches supported by brackets as there are stalls, and in addition to these several portable benches. Every well-managed roundhouse should be provided with a tool-room for the care and maintenance of hand tools and supplies.

An annex should be provided to contain the necessary boiler, pumps and machine tools for making ordinary running repairs, as well as a room for supplies. We would recommend the following machinery, namely, one 30-in. engine lathe, one 12-in. engine lathe, one 30 × 30-in. planer, one 24-in. drill press, one 20-in. shaper, one grindstone, one bolt cutter, one screw or pneumatic press for rod bushings, one blacksmith forge and anvil, etc. Where size of the cylinder demands it, the large lathe should be increased to 36 ins.

We further recommend that the following portable tools be provided, namely, portable crane, valve-facing machine, air motors, air drills and hammers, cylinder boring machine, valve setting apparatus, chain block and fall, hydraulic jacks, small air press, pinch bars, chains, tongs, wrenches, etc.

It is recommended that light tools, wrenches, etc., be kept in the tool-room, while the heavier tools, like jacks, levers, pinch bars, etc., be kept in suitable places in the roundhouse.

ASHES AND CINDERS.—For handling ashes and cinders, we conclude that the cheapest arrangement, and one which is least liable to cause trouble by breaking down, is a depressed track between two tracks, the depressed track to be deep enough so that the ashes can be hoed from the cleaning floor directly into the ash cars, and the double ash tracks being merely for the purpose of having engines desiring quick treatment pass around those which may be a longer time on the pit. If, however, there is not sufficient track room for this arrangement, some mechanical device for taking care of the ashes will have to be resorted to, provided the traffic warrants the expense.

SAND DRYERS.—Considering the cost of fuel, labor and maintenance, your committee is of the opinion that the steam coil sand dryer is the most economical. On the question of furnishing sand to locomotives, the answers were almost unanimously in favor of elevated sand bin, the sand being elevated by compressed air or mechanical means, allowing the sand to flow into sand-boxes by gravity. In this your committee concurs.

WASH-OUT AND STAY-BOLT RECORD.—It is thought desirable by your committee that each engine should carry its own record as to wash-out, stay-bolt inspection, etc., and this can be most conveniently done by means of a card which is always visible in the cab of the locomotive, and can be turned in at the end of each month for file at the master mechanic's office. This should not, however, be construed as displacing the usual roundhouse records, as these should be available when the engine is on the line.

It is the opinion of your committee that stay-bolts should be tested once a month. The hammer test is satisfactory when bolts are completely broken through. When only partially broken it does not tell the story. Where tell-tale holes are drilled, or hollow stay-bolts used, a careful inspection of the tell-tale hole for the presence of lime is considered most satisfactory. It is also desirable that a record should be kept of all such tests. In making the hammer test about 40 or 50 lbs. of steam or air pressure should be used in boiler to separate the ends of the broken bolts.

ROUNDHOUSE FOREMEN.—The opinion was held almost unanimously in favor of machinists filling the position of roundhouse foremen. A few believe that engineers who are also machinists would make good men. Your committee is of the opinion that it is very necessary that a roundhouse foreman should have had practical experience as a machinist, and that if he could have some experience as either a locomotive fireman or an engineer, it would make him a better roundhouse foreman than he could be without such experience, as he would then know the conditions that exist on the road, and could therefore do more intelligent work.

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